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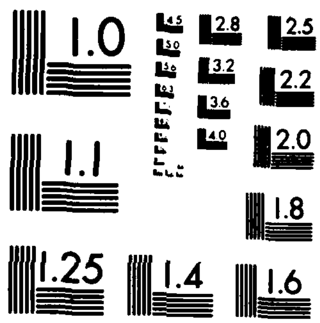


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Watershed modelling of gaged streams in the Chemung and Upper Susquehanna River Basins was attempted using the U.S. Army Corps of Engineers' HEC-1, Flood Hydrograph Package. The Clark method of unit hydrograph theory and the initial and constant loss rate approach were used in this analysis. Parameters were derived from a total of 52 storm events for nine watersheds. Regression equations were derived relating the Clark unit hydrograph paramenters to physical basin characteristics. Regional constant loss rates were established.

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COMPUTER PACKAGE HEC-1

James C. Styron III, CPT, FA
HQDA, MILPERCEN (DAPC-OPP-E)
200 Stovall Street
Alexandria, VA 22332

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# WATERSHED MODELLING IN THE CHEMUNG AND UPPER SUSQUEHANNA RIVER BASINS USING THE US ARMY CORPS OF ENGINEERS COMPUTER PACKAGE HEC-1

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Master of Science

by

James Clyde Styron III

May 1983

## ABSTRACT

Watershed modelling of gaged streams in the Chemung and Upper Susquehanna River Basins was attempted using the U.S.Army Corps of Engineers' HEC-1, Flood Hydrograph Package. The Clark method of unit hydrograph theory and the initial and constant loss rate approach were used in this analysis. Parameters were derived from a total of 52 storm events for nine watersheds. Regression equations were derived relating the Clark unit hydrograph parameter to physical basin characteristics. Regional constant loss rates were established.

## BIOGRAPHICAL SKETCH

The author, James C. Styron III, was born in Hobart, Oklahoma on September 29, 1951. He was graduated from the United States Military Academy at West Point, New York in June 1973 and was commissioned as an officer in the U.S.Army at that time. James has attended and graduated from several Army schools including a German course at the Defense Language Institute in Monterey, California, the field artillery officers advanced course at Fort Sill, Oklahoma, and Airborne and Ranger courses in Georgia.

James is an Army Captain who will be working with the U.S.Army Corps of Engineers upon leaving Cornell.

DEDICATION

To my wife and partner

# ACKNOWLEDGEMENTS

I would like to thank Professor Wilfried H. Brutsaert, my Chairman and thesis advisor. I thank Professor Thomas D. O'Rourke for serving on my Special Committee. A special thanks to Steve Sather, Cornell Computer Services, for his time and effort in making the program compatable with the Cornell IBM computer.

The one person I am more indebted to than any one is my wife and to her I say "Thank you very much!"

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# CHAPTER ONE
# INTRODUCTION

Floods are headline grabbers. Every year floods show us how destructively nature can unleash its power. They receive extensive news coverage which describes the resulting damage and loss of life. Floods disrupt lives and productive endeavors. A great deal of effort has gone into studies of past floods and estimates of future floods in order to develop plans for flood damage reduction and prevention. Richards (1955) wrote, "The flood problem is one which affects many branches of engineering other than those dealing primary with the control of water." He also wrote that the flood estimation problem is a peculiarly difficult and complicated one. Although the natural laws governing floods are both recognizable and generally appreciated, the difficulty lies in the application.

The flood factors which are normally considered the most important are as follows: rain intensity, rainfall distribution, rainfall duration, drainage area, basin shape, basin slope, land cover, and, finally, the initial state of wetness in the soil (Richards, 1955, p. 8).

Hoyt and Langbein (1955) recognized the need for a national policy addressing the flood problem. They hypothesized that some future Congress or Congresses would recog-

nize that "a sound approach to floods must be broader than flood protection alone,...". In their ten point proposal number three is quoted, "Flood-forecasting services should be recognized as an essential part of flood management and be appropriately supported." Indeed, around 1955, the U.S. Weather Bureau (now the National Weather Service, NOAA) received appropriations for its flood-forecasting service averaging about $900,000/year. The savings accredited to this service were roughly estimated at about $27,000,000, implying a cost-benefit ratio of 1 to 30.

Flood-forecasting is certainly not a modern notion. Diodorus Siculus visited Egypt during the 1st Century B.C. (Biswas, 1967, p.125). On the Nile River, the stage of the Nile were maintained by using nilometers (gaging stations). These structures were used to observe the river stage and compare the current height with that of previous high water marks. Little evidence of actual technical co-operation between the temples charged with running the nilometers exists but according to Diodurus, flood warnings were sounded to the population from the nilometer at Memphis (the seat of the government) in case of emergency. The ancients' warning system worked as follows; with the approach of the flood season, the stage of the Nile was carefully watched and compared with the markings of the previous year. Swift rowers were sent from the furtherest upstream gaging stations, one after another, to report the latest

level at the capital. These extremely good rowers, rowing with the current, were able to outpace the approaching peak flood and give sufficient advance warning to the people along the river of the forthcoming catastrophe.

No one would seriously consider instituting a flood prediction system today based on a fleet of rowboats. However, there is a need to forecast floods in a "real-time" setting in order for warnings to be broadcasted, people and property to be evacuated, and emergency resources to be mobilized in the area of the expected threat.

But how does one go about forecasting a flood? This thesis will present only one method. That method is the unit hydrograph approach for ungaged watersheds which was suggested by the U.S. Army Corps of Engineers in its manuals and which will be presented later in Chapter Three. The selection of this method was based in part on the observation of Dooge (1959) who wrote, "The unit hydrograph approach to stream flow has developed into one of the most powerful tools of applied hydrology."

## GOAL AND SCOPE OF THESIS

The goal of this thesis is to use the U.S. Army Corps of Engineer's HEC-1 computer program (discussed in Chapter Three) in developing, (a) Regression relationships between the unit hydrograph parameters (based upon the Clark Method) and some of the more important physical

basin characteristics; and, (b) Regional relationships to determine the initial loss and constant loss rate parameters in the area of interest.

The scope of this thesis is to accomplish the goal by using historical storm and rainfall data from several gaged streams in the area of interest in solving the inverse problem. The inverse problem is defined as a problem in which the input (rainfall) and the output (stream runoff) are known and are used in determining the transfer functions, i.e. the Clark unit hydrograph and loss rate parameters. The area of interest is that of the Chemung and Upper Susquehanna River basins in the state of New York and a small portion of Pennsylvania. Nine gaged stream basins in this area were selected for use in calibrating the computer model HEC-1. These basins which are unregulated were chosen on the basis of their hydrological similarity. The ungaged watersheds in the area around Corning and Elmira, New York, are the main targets of this modelling effort.

## OVERVIEW

This work is organized into six chapters. Chapter One is the introduction in which the consequences of floods, the need for flood prediction, and the goal and scope of this thesis were presented. Chapter Two is a literature review primarily concerned with the origins of the HEC-1

approach selected for this study. Chapter Three describes the specific method employed to obtain the results. Chapter Four presents the data and calculations performed in the application of the method in the area of interest. Chapter Five is a discussion of the results. Chapter Six presents conclusions reached by this author and other authors. Several appendices are provided to keep the basic chapters as free as possible from "data overload" and are identified in the basic work.

# CHAPTER TWO

# LITERATURE REVIEW

## PURPOSE AND SCOPE

The purpose of this chapter is to trace the development of the unit hydrograph theory and its application in flood prediction on ungaged basins. The scope of this chapter is confined to a brief discussion of the origins of the three components of the HEC-1 model with a limited presentation of other methods.

## LOSSES

The term precipitation loss is defined in this thesis as the amount of precipitation not available during a storm for overland flow. There are basically two types of precipitation losses. One is called interception. It represents the amount of rainfall which is held by the trees, grass and local depressions such as potholes and cracks. Anything that traps and does not allow the rainfall to move about freely is classified under this type of loss. The other type of precipitation loss is infiltration. It represents the amount of rainfall absorbed into the earth.

In computing rainfall excess, the precipitation losses are subtracted from the total storm rainfall. Sokolov et al. (1976, p.175) listed five methods to determine rainfall losses. They are mentioned below:

1. Constant runoff coefficient, which is the ratio of surface-runoff depth to total rainfall depth.
2. Constant infiltration rate during a storm known as the $\Phi$-index in the U.S.
3. Initial rainfall loss followed by a constant infiltration rate. In this method all rainfall is considered to be lost until an initial rainfall-loss demand has been satisfied. Thereafter, rainfall is lost at a constant rate.
4. Regional curves of infiltration capacity, that are variable with time, and are based on soil type, land use, and an antecedent-rainfall index.
5. A variable runoff coefficient $\alpha_t$ method, which varies with time, even during storm periods, in response to the variation of a basin moisture index.

Any one of these methods may be included in a basin model. HEC-1 uses the methods described in 3. and 4. above and will be discussed further in Chapter Three.

## UNIT HYDROGRAPH

### ORIGINAL UNIT HYDROGRAPH THEORY

Sherman (1932, p. 501) first proposed the unit-graph (as it was originally called) method as a way to predict flood-peak discharges and discharge hydrographs from rainfall events. Sherman defined the unit-graph as follows:

> If a given one-day rainfall produces a 1-inch depth of rainfall over the given drainage area, the hydrograph showing the rates at which the runoff occurred can be considered a unit-graph for the watershed.

The unit hydrograph (unit-graph) theory makes two assumptions: 1) Runoff response to rainfall is time invariant. 2) Runoff response to rainfall is linear; this implies the principle of superposition. These assumptions are not rigorous and there is some flexibility.

By means of the second assumption, Sherman observed the possibility of computing the runoff history corresponding to a rainfall of any duration or degree of intensity for the same watershed from a single observed hydrograph. In applying his method, he noted, that the ordinate and time intervals of unit hydrographs for two similar watersheds of different sizes are proportional to the square root of the watershed areas, provided the difference in size is not great. He also observed that consistent results in the data were based upon the observations being confined to a single area or to closely similar areas and being segregated accodring to the seasons.

Unit hydrograph methods are usually based on the ability to separate the surface-runoff hydrograph from the hydrograph of the total rainfall. The total hydrograph is often assumed to consist of three types of flow defined below by Dooge (1959, p. 241): 1) Surface runoff, or the water reaching surface channels by the overland route; 2) Interflow, or the portion of infiltrated water that passes through the shallower horizons of the soil to reach defined stream channels within a relatively short time, without first

reaching the main ground-water table; and, 3) Base flow, or the water contributed as ground water outflow from an aquifer. It should be noted that interflow is usually combined with surface runoff and collectively called surface runoff.

LATER UNIT HYDROGRAPH DEVELOPMENTS

In 1934, 1936 and 1937 Zoch (Dooge, 1959, p.241) published several papers on the unit hydrograph method based on the assumption that at any time the rate of discharge is proportional to the amount of rainfall remaining with the soil at that time. The S-hydrograph method developed by Morgan and Hullinhors (1939) employed a unit hydrograph of a certain duration to form an S-hydrograph resulting from a continuous applied rainfall to construct unit hydrographs for other than the original duration.

Snyder (1938, p.447) and Taylor and Schwartz (1952, p. 235) applied unit hydrograph theory to basins by relating features of the unit hydrograph to watershed characteristics by strictly statistical considerations. Their attempts led to the "synthetic unit hydrograph method."

In contrast to this statistical approach, several workers attempted to give a more conceptual basis to the unit hydrograph. Clark (1945, p. 1419) developed the instantaneous unit hydrograph (IUH) method by suggesting the unit hydrograph for instantaneous rainfall could be derived by routing

the time-area-concentration curve through a single element of linear reservoir storage. O'Kelly (1955, p. 365) of the Irish Office of Public Works suggested replacement of the time-area-concentration curve by an isosceles triangle. Nash (1957, p. 114) noted that the instantaneous unit hydrograph could be derived by routing the instantaneous rainfall through a series of successive linear reserviors of equal delay time. Dooge (1959, p. 241) attempted to remove many of the subjective elements from unit hydrograph analysis. The number of IUH investigations goes on and on. Chow (1964, p. 14-25) compiled an extensive list of past accomplishments in his handbook. He concluded that the use of the IUH rather than other unit hydrograph methods is better suited for investigations on the rainfall and runoff relationship in drainage basins.

## CLARK'S METHOD OF UNIT HYDROGRAPH ANALYSIS

Clark (1945, p. 1422) was the first to adapt the idea of the IUH in hydrograph analysis to the unit hydrograph theory. In his original work he wrote:

> "The range of possible unit-graph determinations can be reduced by correlating recognized discharge concepts with the physical limitations of valley storage and with the time elements which necessarily result from storage and discharge relations. The correlation can be utilized to develop, from time-area-concentration curves of specific drainage areas, unit hydrographs with a small range of determination variability, independent of assumptions regarding runoff distribution in the flood-producing storm and reflecting influences of drainage area shape and stream pattern."

He showed the relationship between the unit hydrograph and the methods of flood routing (means of modifying a hydrograph by the effects of valley storage). Clark stated that one advantage of using an "instantaneous hydrograph is that it can be derived from the fundamental characteristics of the basin and then used with any length of unit period to determine the unit hydrograph, ...". Other advantages stated by Clark which make his method appealing to "real-time" flood forecasting are: 1) The procedure is definable. Identical hydrographs will be obtained by different people. 2) Determination is independent of any knowledge of runoff distribution, except the time of ending. 3) The unit hydrograph quantities are instantaneous rates of discharge at the time specified.

FLOOD ESTIMATION: UNIT HYDROGRAPH

Richards (1955, p.10) presented the principal factors affecting floods. A number of flood formulas is discussed and a brief outline of the flood frequency, probability, and unit hydrograph methods used in the U.S. is included. Sokolov (1976, p.182) states that flood flow computations for unit hydrograph derivation are accomplished using three general methods: 1) Analysis of rainfall--runoff records for isolated unit storms, 2) Analysis of rainfall--runoff records for major storms, and 3) Computation of synthetic unit hydrographs from a) Direct analogy with

basins of similar characteristics, or b) Indirect analogy with a large number of other basins through the application of empirical relations.

BASIN CHARACTERISTICS USED IN HYDROGRAPH ANALYSIS

POSSIBLE PARAMETERS

Relating model parameters to physical basin characteristics is the major purpose of this study. The geomorphic and geophysical structures of a basin play an important part of the watershed's response to rainfall. Many basin characteristics have been used in the past to relate a response of precipitation to physical structures in a watershed. Linsley (1982, p.311-316) defines several characteristics of interest in this study. They are: drainage area, stream density, basin shape, channel slope, and channel length.

In a very large study of the Northeastern U.S., Langbein (1947, p.125) using U.S. Geological Survey (USGS) topographic maps of 340 basins withdrainage areas of 1.64 to 7,797 square miles collected data on drainage, area, length of streams, stream density, land slope, channel slope, area-altitude distribution, and area of water bodies of the basins. Characteristics were divided into geographic such as water bodies, direction of stream flow, latitude and longitude,and topographic such as basin area, stream

length, area-distance distribution, land slope, basin altitude, and tributary and principal stream slopes. A principal channel was defined as one that drains more than ten percent of the total area while a tributary channel drains less than ten percent of the total area. Their conclusions were that many characteristics have a direct relationship with other characteristics; for example, steep land slopes imply steep channel slopes and stream density tends to vary with the land slope. The study showed that no one element is unique in any one basin and that not all characteristics must be correlated to model parameters to get satisfactory regression relationships.

SOME UNIT HYDROGRAPH APPLICATIONS

Taylor and Schwarz (1952, p.235) published a study based on 65 rainfall excess periods over 20 basins in the North and Middle Atlantic States with varying drainage areas of 20 to 1600 square miles. Their results were that the drainage area, length of longest watercourse, length to center of area and the equivalent mainstream slope were the most significant basin characteristics.

Brater's (1940, p.1154) study indicated that the unit hydrograph method is one of the best practical devices for predicting flood flows. His work based on 22 small

watersheds in the Southern Appalachians of varying cover with areas of 4.24 to 1,876.7 acres showed that the unit hydrograph principle "permits the engineer to estimate not merely the peak discharge, but the entire hydrograph of runoff. The peak may be determined for any desired time interval."

Analyzing data on nine streams tributary to the Chemung River in New York, Morgan and Hullinghorst (1939, p. 1) found good correlation to the area of the watershed, mean length of travel and the mean height of the watershed above the outflow.

Unit hydrographs were used in a flood-frequency work by Kinnison and Colby (1945). On about 48 basins in Massachusetts, the characteristics, found to be most influential, were: median altitude (s), drainage area (M) and the average distance which water from runoff uniformly distributed over the basin must travel to the outlet (L). Thus M is a measure of the volume of water to be discharged, <u>s</u> is a measure of the fall and L is a measure of the distance that the water travels to the point of discharge.

More recent works by Rodriguez and Gonzalez (1982, p. 877) and Rodriguez et al.(1982, p. 887) have applied the geomorphoclimatic theory of the IUH. Their works have helped to explain much of the noise observed in relating IUH parameters to basin characteristics without considering the

coupling effects of the climate and geomorphology on a basin.

Hence, it seems that most authors use easily definable basin characteristics such as main channel length, main channel slope and drainage area to obtain their hydrograph response relationships to basin charactersitics.

## BASE FLOW

The release of water from underground storage into the channel is called base flow. Dooge (1973, p. 89) has presented a thorough discussion of the subject as well as its separation from the total storm hydrograph. Although several methods exist to calculate base flow, the difference between the methods is not significant in relation to the total flow in the channel during a major storm.

# CHAPTER THREE
# METHOD

## PURPOSE AND SCOPE

The purpose of this chapter is to describe the method used in determining HEC-1 parameters for the study region's gaged basins and in developing the relationships between unit hydrograph parameters and basin characteristics. The scope of this chapter is to present the HEC-1 options employed and the multiple regression scheme used in this thesis.

## WHAT IN THE HECK IS HEC-1?

HEC-1 is the shortened name of HEC-1 Flood Hydrograph Package, Computer Program 723-x6-L2010, with its latest revision taking place in September 1981. The program was developed at the Hydrologic Engineering Center (HEC), Davis, California, which is a part of the U.S. Army Corps of Engineers' Water Resources Support Center. The original development of HEC-1 was made in 1967 by Leo Beard and others (HEC-1,'81), with the first version being published in October 1968. Major revisions have been made in 1969,1970, 1973, and 1981. The current version has the major additional capabilities of the dam-break (HEC-1DB), project optimization (HEC-1GS), and the kinematic wave (HEC-1KW) programs included in the package.

The HEC-1 model is designed to simulate the surface runoff response of a river basin to precipitation by representing the basin as an interconnected system of hydrologic and hydraulic components within a portion of the basin, commonly called a subbasin. A component represents a surface runoff entity, a stream channel, or a reservior. Representation of a component requires a set of parameters which specify the particular characteristics of the component and mathematical relations which describe the physical processes. The result of the modelling process is the computation of streamflow hydrographs at desired locations in the river basin.

As previously stated in the Introduction under Scope and Goals, this thesis will use HEC-1 to model gaged basins in order to determine values for parameters of a surface runoff entity component which will be used as a predicting tool for ungaged basins in the region of interest

## ASSUMPTIONS AND LIMITATIONS

As pointed out in the HEC-1 Users Manual, HEC-1 makes a number of assumptions and has some limitations. The major assumptions are that hydrologic processes such as precipitation and interception/infiltration, may be represented by model parameters which reflect average conditions within a subbasin; model parameters represent temporal as well as spatial averages. Some of its limitations are that simu-

lation is limited to a single storm event (because HEC-1 does not have the ability to account for soil moisture recovery during periods of no precipitation) and that results are given in discharge rates rather than in stage heights.

## HYDROLOGIC ANALYSIS PROCEDURES OF UNGAGED WATERSHEDS USING HEC-1

Guidelines and methods for modelling ungaged basins are presented in a HEC report entitled "Hydrologic Analysis of Ungaged Watersheds Using HEC-1", Training Document No. 15, April 1982. This report formed the methodology used in this thesis. The report gave detailed techniques for estimating and calibration of HEC-1 model parameters including discussions of the runoff transformation and loss rate parameters.

Below is outlined the basic method used in the regional analysis of watershed characteristics of this thesis (which is described in greater detail in the Report):

1. Collect precipitation and runoff information for a range of major flood events (usually 5-10 for each gaged basin) in the region. Identify the watershed boundaries on a topographic map where the gaging stations are taken as the basin outlets.
2. Run a HEC-1 rainfall-runoff analysis to optimize

the unit hydrograph and loss rate parameters for the gaged drainage areas.

3. Correlate the unit hydrograph and loss rate parameters with basin characteristics and develop generalized relationships for these parameters.

4. Use the generalized relationships to compute parameters for the ungaged basins by means of measurable basin characteristics.

5. Perform a watershed simulation using HEC-1 for several historical storm events for verification of reconstituted runoff peaks and volumes at gaged locations. If unsatisfactory results are obtained, the analysis is repeated after adjusting the parameters.

## RAINFALL-RUNOFF SIMULATION

The rainfall-runoff simulation involves five processes.

They are precipitation, interception/infiltration, transformation of precipitation excess to basin outflow, baseflow, and flood routing (not used in this study). Each of the first four processes will be discussed below.

## PRECIPITATION

The precipitation distribution chosen for this study among the possibilities in HEC-1 was the method of weighted precipitation gages. This method determines a basin average rainfall amount for a historical storm and distributes it temporally over the entire basin. This process produces a precipitation hyetograph.

Each gaged basin in the study region was divided into Thiessen polygons (see Linsley (1982, p. 71) for the Thiessen polygon method). With one rain gage per polygon, the area of each polygon covering the basin could be determined using a planimeter. The area of a polygon divided by the total basin drainage area yielded the percent (expressed as a decimal) of the relative weight for each rain gage. Thiessen polygons were drawn for the recording (hourly measurements) and non-recording (daily measurements) rain gages. To obtain the total storm precipitation the relative weights were placed on the PT-PW input cards (input card data/format will be discussed later in Chapter Four) for the recording and non-recording gages which actually contributed rain

to the basin. However, in order to develop the temporal pattern on the basin, the relative weights placed on the PR-PW input cards only used recording rain gage polygons.

The total storm precipitation for a basin was computed as the weighted average of measurements from several gages using the formula:

$$\text{PRCPA} = \frac{\sum_{J=1}^{n} \text{PRCPN(J)} * \text{WTN(J)}}{\sum_{J=1}^{n} \text{WTN(J)}}$$

where PRCPA is the basin average total precipitation, PRCPN(J) the total precipitation for gage J, WTN(J) the relative weight for gage J, and n the number of gages.

The temporal pattern for distribution of the storm-total precipitation is computed as a weighted average of temporal distributions from recording stations using the formula:

$$\text{PRCP(I)} = \frac{\sum_{J=1}^{n} \text{PRCPR(I,J)} * \text{WTR(J)}}{\sum_{J=1}^{n} \text{WTR(J)}}$$

where PRCP(I) is the basin-average precipitation for the Ith time interval, PRCPR(I,J) the recording station precipitation for the gage J.

The basin-average precipitation hyetograph is then computed using the temporal pattern, PRCP, to distribute the total rainfall amount, PRCPA, see Figure 3.1.

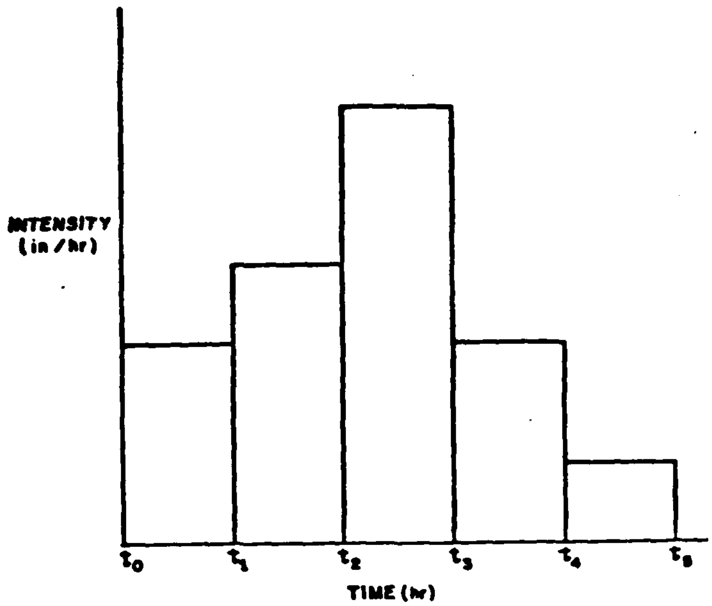



Figure 3.1. Precipitation Hyetograph (HEC-1, 1981).

INTERCEPTION/INFILTRATION

Definitions. Interception and depression storage are intended to represent the surface storage of water by trees or grass, local depressions in the ground surface, in cracks and crevices in parking lots or roofs, or in a surface area where water is not free to move as overland flow. Infiltration represents the movement of water to areas beneath the land surface. Both of these are lumped together in HEC-1 and considered as precipitation losses.

Two important factors should be noted about this process: one, precipitation which does not contribute to the runoff process is considered to be lost from the system and two, there is no provision in the model for soil moisture or surface storage recovery. The second factor has already been mentioned under the Assumptions and Limitations

portion of this chapter.

As in the precipitation process, the interception/ infiltration process uniformly distributes the precipitation loss over the entire basin. This process yields a basin-average for rainfall losses. There is a feature in the model in which a percentage of the basin may be labeled as impervious and no losses are calculated for this portion; however, this feature was not used in this study.

Four different methods may be used in calculating the precipitation loss. By using any one of these methods, an average precipitation loss is determined for a computation interval and subtracted from the rainfall hyetograph. The resulting precipitation excess is used to compute an outflow hydrograph for a subbasin as is shown in Figure 3.2.

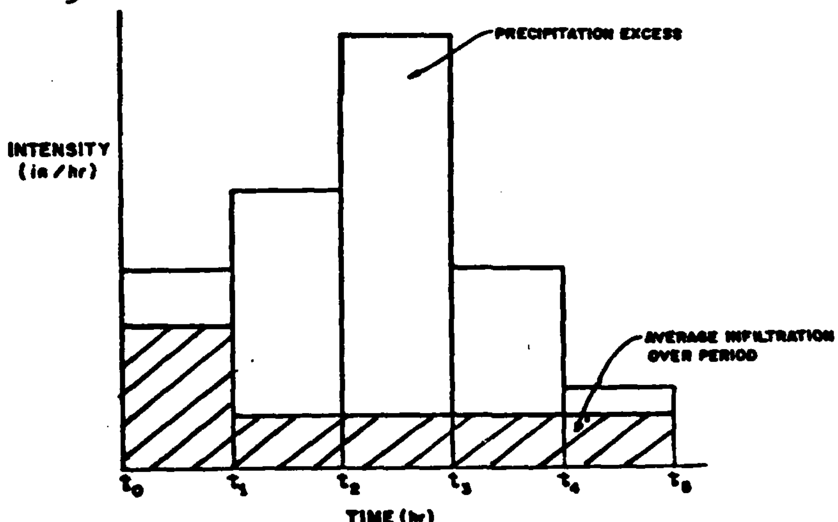



Figure 3.2. Input Hyetograph (HEC-1, 1981).

The four methods available to calculate rainfall

losses are initial and uniform loss rate, exponential loss rate, Soil Conservation Service (SCS) curve number, and the Holtan loss rate. This thesis only considered the initial and uniform loss rate. It will be the only method discussed here.

The initial and uniform loss rate method has two parameters; an initial loss, STRTL (units of depth), and a constant loss rate, CNSTL (units of depth/hour). All rainfall is lost until the volume of initial loss is satisfied. After the initial loss is satisfied, rainfall is lost at the constant rate, CNSTL. These parameter values are entered as input on the LU card.

TRANSFORMATION OF PRECIPITATION EXCESS TO BASIN OUTFLOW

The transformation of rainfall excess into basin outflow for this thesis is accomplished through the unit hydrograph technique, more specifically, the technique that was proposed by Clark (1945) which has already been discussed in Chapter Two.

The basic methodology of any unit hydrograph component inHEC-1 is the same. The rainfall excess hyetograph is transformed to a subbasin outflow by utilizing the general equation:

$$Q(i) = \sum_{i=1}^{N} \sum_{j=1}^{i} U(j) * X(i-j+1)$$

where Q(i) is the subbasin outflow at the end of computation-

al interval i, U(j) the jth ordinate of the unit hydrograph, X(i) the average rainfall excess for the computational interval i, and N the number of rainfall ordinates.

Application of the unit hydrograph technique implies two assumptions: one, the unit hydrograph is characteristic of the subbasin and is not storm dependent and two, runoff due to excess from different periods of rainfall excess may be linearly superposed.

The Clark unit hydrograph requires three parameters to calculate a unit hydrograph: the time of concentration for the subbasin, TC (units of time), a storage coefficient, R (units of time), and a time-area curve.

The time of concentration, TC, may be defined conceptually as the amount of time required for a particle of water deposited at the furtherest point upstream in the watershed to travel through the watershed until it passes the subbasin outlet. TC is estimated by the lag time between the end of the runoff producing rainfall to the inflection point on the recession limb of the surface runoff hydrograph.

The storage coefficient, R, is used to account for the effect of subbasin storage on the hydrograph. This parameter is estimated by dividing the flow at the recession inflection point of the surface runoff hydrograph by the rate of change of discharge (slope) at this same time. See Figure 3.3.

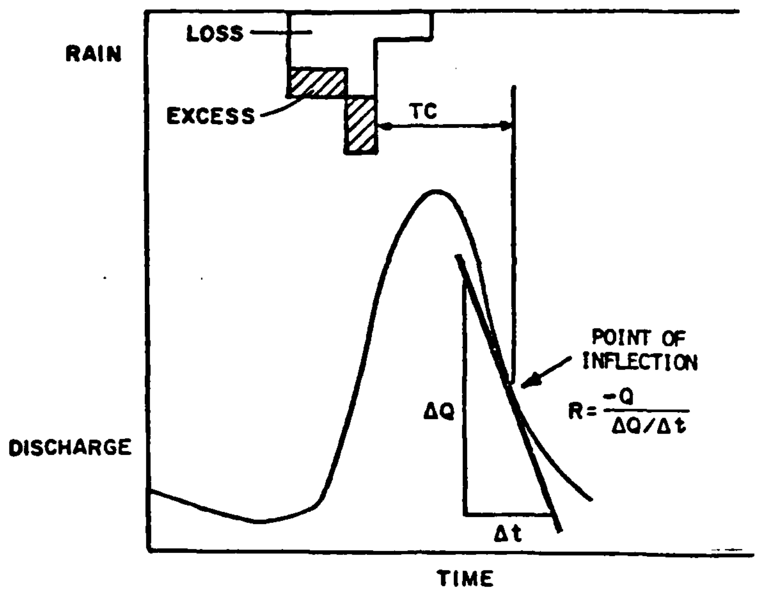



Figure 3.3. Clark UH Parameters (HEC-1, 1981).

The time-area curve defines the cumulative area of the watershed contributing runoff to the subbasin outlet as a function of time (expressed as a portion of TC).

No developed time-area curves for any of the gaged subbasins in the study region could be found, therefore, use of the HEC-1 synthetic dimensionless time-area curve was made. The equations of this curve are:

$$AI = 1.414\, T^{1.5} \qquad 0 \le T < .5$$

$$1 - AI = 1.414\, (1-T)^{1.5} \qquad .5 \le T \le 1$$

where AI is the cumulative area as a fraction of the total subbasin area and T the fraction of the time of concentration. See figure 3.4.

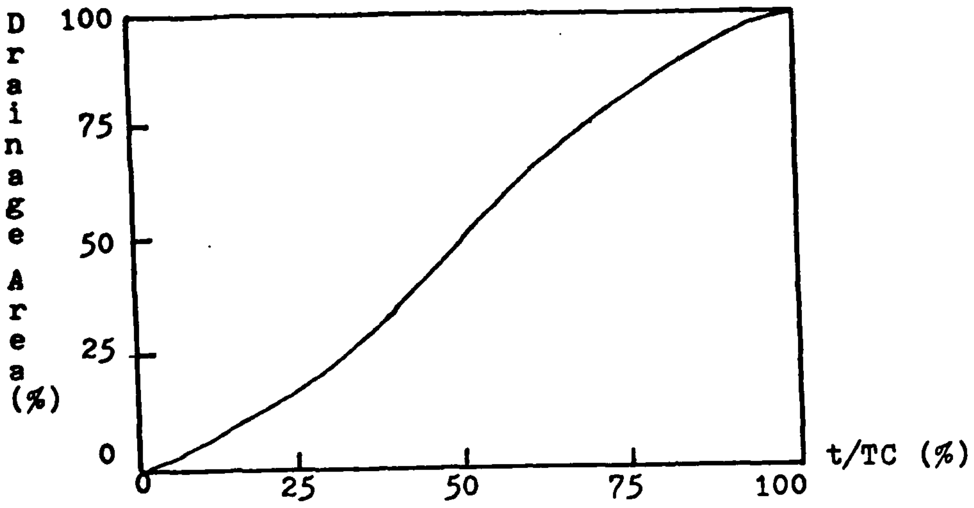



Figure 3.4. Synthetic Time-Area Curve

The ordinates of the time-area curve are converted to volume of runoff per second for unit excess and interpolated to the given time interval. This results in the development of a translation hydrograph which is then routed through a linear reservoir to simulate the storage effects of the subbasin. The routing produces a unit hydrograph for instantaneous excess which is averaged to yield the hydrograph for unit excess occurring in the given time interval (one hour in all cases of this thesis).

The linear reservoir routing is accomplished using the equation

$$Q(2) = CA * I + CB * Q(1)$$

where the routing coefficients are

$$CA = \Delta t/(R + .5\Delta t)$$

$$CB = 1 - CA$$

$$QUNGR = .5(\ Q(1) + Q(2)\ )$$

and where Q(2) is the instantaneous flow at the end of the period, Q(1) the instantaneous flow at the beginning of the period, I the ordinate of the translation hydrograph, $\Delta t$ the computational time interval (one hour in all cases in this study), R as previously defined, and QUNGR the unit hydrograph at the end of the computation interval.

The parameters TC and R are entered as input on the UC card.

BASEFLOW

Unlike direct surface runoff which is calculated as the total precipitation minus the losses, baseflow is defined as the release of water from subsurface storage. To include baseflow effects the HEC-1 model must be supplied with three input parameters, STRTQ, QRCSN, and RTIOR.

STRTQ is the initial discharge (starting flow) in the stream outlet at the beginning of the storm. It is the flow at the outlet at the beginning of the rainfall hyetograph. It is affected by the long term contribution of groundwater releases in the absence of precipitation and is a function of antecedent conditions.

QRCSN is the flow on the receding limb of the computed hydrograph at which an exponential recession begins.

RTIOR is a user specified exponential decay rate

which is assumed to be characteristic of the subbasin. It is equal to the ratio of a recession limb flow occurring one hour later. See Figure 3.5.

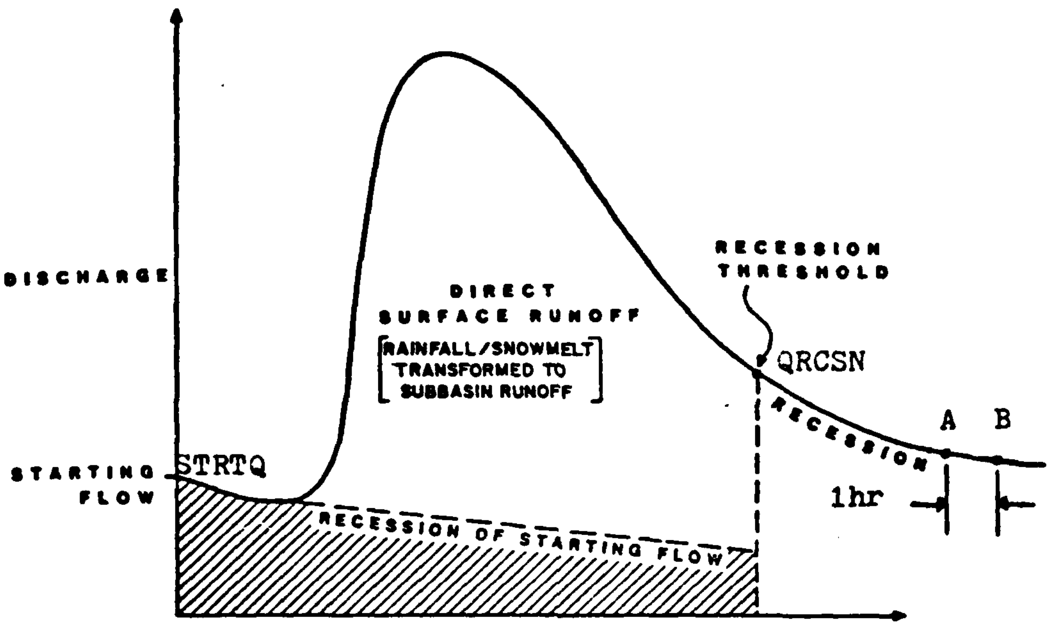



Figure 3.5. Base Flow Parameters (HEC-1, 1981).

Baseflow or recession flow is computed with the equation:

$$Q = Q_o \ (RTIOR)^n$$

where Q is STRTQ or QRCSN and n the number of time intervals since recession was initiated.

The values of QRCSN and RTIOR are obtained by plotting the observed flows (starting at the peak) versus time on semi-log paper. The point at which the flows begin to become a straight line defines QRCSN. See Figure 3.6.

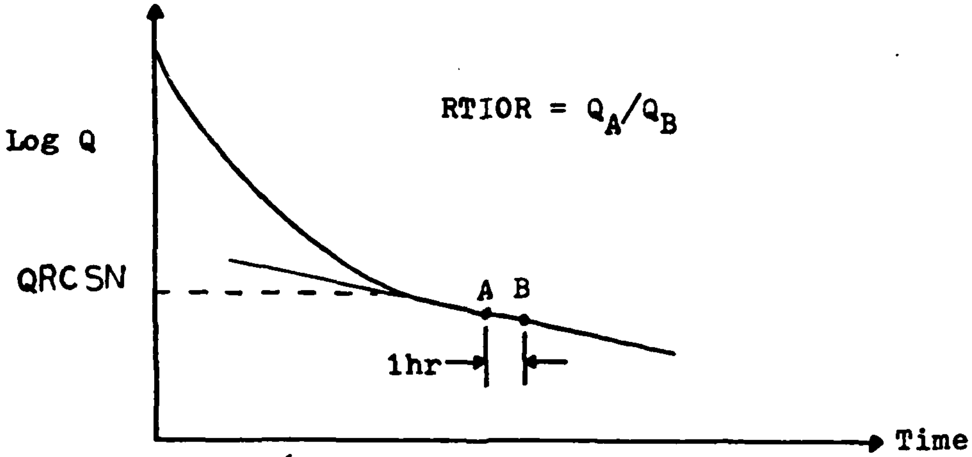



Figure 3.6. QRCSN and RTIOR Determination.

RTIOR is usually obtained by taking the average ratio of $Q_a$ and $Q_b$ (flows one hour apart) of several, usually about ten, along the straight line portions of Figure 3.6 In this study a subbasin average is determined by taking the average RTIOR for each storm on the basin and then averaging these values. The subbasin average was then held constant throughout all calculations for that subbasin while using HEC-1.

The computed flood hydrograph is adjusted to include the baseflow. At the beginning of a storm the baseflow is computed starting at STRTQ and decays according to the formula above until the computed flood flow on the falling limb equals the value of QRCSN. From then on, the flood flow is calculated using the base flow equation as the computed flood flow unless the computed flow rises above

the recession flow. This would occur in the case of a double-peaked hydrograph such as in Figure 3.7.

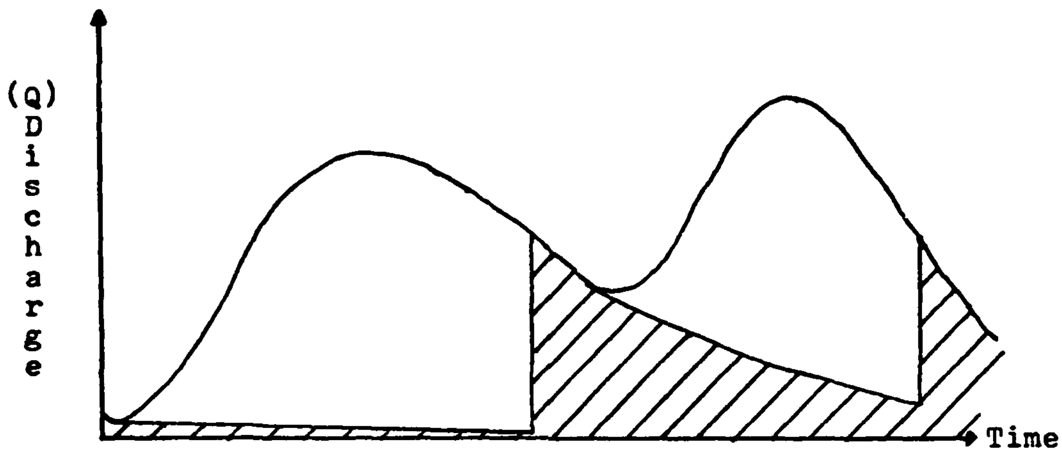



Figure 3.7. Double-Peaked Recession Flow

CALIBRATION OF MODEL PARAMETERS

As with all numerical models, the HEC-1 rainfall-runoff model for single event simulation requires data for calibration in order to be a predictive tool. The parameters of the numerical model are determined by using observed precipitation and runoff data to solve the inverse problem; in other words, given the system input (precipitation) and system output (runoff), the inverse problem consists of defining the characteristics of a system, that produces the transformation from input to output. HEC-1 has two approaches to transform rainfall values to runoff. They are the unit hydrograph and kinematic wave approaches. The unit hydrograph is the

is the most commonly used and was the approach selected for this study. The unit hydrograph approach assumes that a single unit hydrograph is appropriate for all magnitudes of rainfall excess. HEC-1 has three unit hydrograph methods available in its package, those of Clark, Snyder, and the Soil Conservation Service (SCS). The U.S. Army Corps of Engineers uses the Clark unit hydrograph technique most frequently and for this reason was the technique selected for this thesis.

HEC-1 has the capability of automatically producing its "best" estimate of selected model parameters through its optimization subroutine. This subroutine selects those values of the parameters, which yield the "best" reproduction of some measured runoff event with the available measured precipitation data and the selected modelling approach. This automatic calibration approach is accomplished through an objective function, defined as;

$$STDER = \sqrt{\sum_{i=1}^{N} \left( (QOBS_i - QCOMP_i)^2 * WT_i \right)}$$

where STDER is the error index, $QOBS_i$ the observed runoff hydrograph ordinate for period i, $QCOMP_i$ the computed runoff hydrograph ordinate for period i, computed by HEC-1 with current parameter estimates. N is the total number of hydrograph ordinates and $WT_i$ a weight for the hydrograph ordinate defined as;

$$WT_i = (QOBS_i + QAVE)/(2 * QAVE)$$

where QAVE is the average computed discharge.

The STDER calculation for optimization may be viewed graphically as in Figure 3.8,

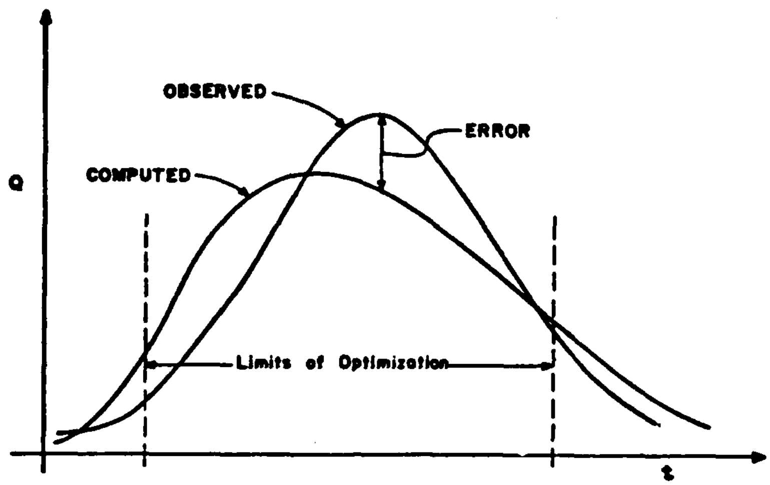



Figure 3.8. Optimization Calculation (HEC-1, 1981)

in which the limits of optimization may be user specified on the OU input card in order to get a better fit on the portion of the curve which is of interest.

The $WT_i$ term biases the objective function by emphasizing accurate reproduction of peak flow rather than low flow. The objective of this function is to minimize the value of STDER in order to get the "best" fit. The word "best" has been placed in quotation marks to indicate that the values determined through this optimization technique do not guarantee that the values are global solutions; indeed an example of this is shown in Chapter

Five. A better solution may be found by varying the starting values of the parameters from their default values selected by HEC-1 in its first run. These default values are listed below:

| Parameter Name | Initial Value |
|---|---|
| TC + R | $(\text{Drainage Area } (\text{mi}^2))^{1/2}$ |
| R/(TC + R) | 0.5 |
| STRTL | 1.00 |
| CNSTL | 0.1 |

The user also has the option of designating initial values for model optimization as well as designating which parameters are to be held constant during the optimization. Assignment of the initial values is discussed in the HEC-1 Programmer's Manual, October 1981. Constraints are placed on parameter values. These values are bounded by a range of feasible values because of the physical limitations on the values that the various unit hydrograph and loss-rate parameters may have. These constraints are:

$$TC + R \geq 1.03\,\Delta t/(1-R/(TC+R))$$

$$R \geq .52\Delta t$$

where t is the computation interval which is one hour in all cases in this study.

$$STRTL \geq 0$$

$$CNSTL \geq 0$$

A complete discussion of the optimization technique as well as the algorithm is presented in the HEC-1 User's Manual. The technique is a univariate search technique in which each parameter value to be optimized is varied one at a time with all other parameters held constant. The "best" value of each parameter is estimated by Newton's method. After each parameter is estimated in turn through four complete cycles, the parameter which most improved the objective function in its last change is adjusted again. This adjustment continues until no one parameter yields a reduction in the objective function of more than one percent. After one more complete search of all parameters, a final adjustment to the computed hydrograph volume to within one percent of the observed hydrograph volume is made. The final objective function value is determined from this final adjustment. An example of the optimization output is shown in Figure 3.9.

Listed first are the initial values of the parameters. The asterisked (*) values denote which variable was changed and its "optimum" value along with the objective function value with the other parameters.

After the objective function routine is printed, the optimization results are blocked out followed by a statistical summary. If the user specifies optimization limits on the OU card, two summaries are printed. The first contains statistics based on the optimization region

```
                         INITIAL ESTIMATES FOR OPTIMIZATION VARIABLES
              TC+R  R/(TC+R)     STRTL     CNSTL
             27.00      0.67      1.00      0.08

                       INTERMEDIATE VALUES OF OPTIMIZATION VARIABLES
                         (*INDICATES CHANGE FROM PREVIOUS VALUE)
                          (-INDICATES VARIABLE HAS NOT CHANGED)
 OBJECTIVE
  FUNCTION       TC+R  R/(TC+R)     STRTL     CNSTL
VOL. ADJ.      27.000     0.667    0.907*    0.073*

     203.9    25.919*     0.667     0.907     0.073
     169.2     25.919    0.960*     0.907     0.073
     165.6     25.919     0.960    0.874*     0.073
     165.4     25.919     0.960     0.874    0.073*

     165.4    25.919*     0.960     0.874     0.073
     165.3     25.919    0.954*     0.87-     0.073
     165.0     25.919     0.954    0.870*     0.073
     164.8     25.919     0.954     0.870    0.076*

     164.7    25.813*     0.954     0.870     0.076
     164.7     25.813    0.953*     0.870     0.076
     164.6     25.813     0.953    0.866*     0.076
     164.5     25.813     0.953     0.866    0.075*

     164.5    25.729*     0.953     0.866     0.075
     164.4     25.729    0.952*     0.866     0.075
     164.4     25.729     0.952    0.863*     0.075
     164.2     25.729     0.952     0.863    0.076*

     164.2    25.660*     0.952     0.863     0.076
VOL. ADJ.      25.660     0.952     0.863     0.076
```

```
**************************************************
*                                                *
*             OPTIMIZATION RESULTS               *
*                                                *
**************************************************
*                                                *
*     CLARK UNITGRAPH PARAMETERS                 *
*          TC      1.24                          *
*           R     24.42                          *
*                                                *
*     SNYDER STANDARD UNITGRAPH PARAMETERS       *
*          TP      2.16                          *
*          CP      0.09                          *
*                                                *
*     LAG FROM CENTER OF MASS OF EXCESS          *
*     TO CENTER OF MASS OF UNITGRAPH     24.41   *
*                                                *
*     UNITGRAPH PEAK        1697.                *
*     TIME OF PEAK          3.03                 *
*                                                *
**************************************************
*                                                *
*                                                *
*     UNIFORM LOSS RATE PARAMETERS               *
*         STRTL     0.86                         *
*         CNSTL     0.08                         *
*                                                *
**************************************************
```

```
**************************************************************************************************
*                                                                                                *
*                         COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS                        *
*                                                                                                *
**************************************************************************************************
*                                                                                                *
*                          STATISTICS BASED ON OPTIMIZATION REGION                               *
*                               (ORDINATES    5 THROUGH   30)                                    *
*                                                                                                *
**************************************************************************************************
*                                                                                                *
*                                                         TIME TO      LAG                       *
*                             SUM OF    EQUIV       MEAN   CENTER   C.M. TO     PEAK   TIME OF   *
*                              FLOWS    DEPTH       FLOW  OF MASS      C.M.     FLOW      PEAK   *
*                                                                                                *
*   PRECIPITATION EXCESS                0.783              13.62                                 *
*                                                                                                *
*   COMPUTED HYDROGRAPH       19831.    0.397       763.   20.98      7.16     1345.    16.00    *
*   OBSERVED HYDROGRAPH       19676.    0.393       757.   20.48      6.67     1375.    21.00    *
*                                                                                                *
*   DIFFERENCE                  161.    0.003         6.    0.50      0.50      -30.    -5.00    *
*   PERCENT DIFFERENCE          0.82                                  7.46     -2.19             *
*                                                                                                *
*              STANDARD ERROR    138.            AVERAGE ABSOLUTE ERROR      107.                *
*          OBJECTIVE FUNCTION    144.    AVERAGE PERCENT ABSOLUTE ERROR      22.05               *
*                                                                                                *
**************************************************************************************************
*                                                                                                *
*                           STATISTICS BASED ON FULL HYDROGRAPH                                  *
*                               (ORDINATES    1 THROUGH   40)                                    *
*                                                                                                *
**************************************************************************************************
*                                                                                                *
*                                                         TIME TO      LAG                       *
*                             SUM OF    EQUIV       MEAN   CENTER   C.M. TO     PEAK   TIME OF   *
*                              FLOWS    DEPTH       FLOW  OF MASS      C.M.     FLOW      PEAK   *
*                                                                                                *
*   PRECIPITATION EXCESS                0.783              13.62                                 *
*                                                                                                *
*   COMPUTED HYDROGRAPH       30592.    0.612       637.   26.93     13.31     1345.    16.00    *
*   OBSERVED HYDROGRAPH       25237.    0.505       526.   24.15     10.53     1375.    21.00    *
*                                                                                                *
*   DIFFERENCE                 5355.    0.107       112.    2.78      2.78      -30.    -5.00    *
*   PERCENT DIFFERENCE         21.22                                 26.89     -2.19             *
*                                                                                                *
*              STANDARD ERROR    206.            AVERAGE ABSOLUTE ERROR      166.                *
*          OBJECTIVE FUNCTION    205.    AVERAGE PERCENT ABSOLUTE ERROR      53.49               *
*                                                                                                *
**************************************************************************************************
```

Figure 3.9. Optimization Output.

while the second summary is based upon the entire flood hydrograph.

The definition of the terms used in the summary are self-explanatory except for the following four terms;

Standard Error-the root mean squared sum of the difference between observed and computed hydrographs.

Objective Function--the weighted root mean squared sum of the difference between observed and computed hydrographs.

Average Absolute Error--the average of the absolute value of the differences between observed and computed hydrographs.

Average Percent Absolute Error--the average of absolute value of percent difference between observed and computed hydrograph ordinates.

## APPLICATION OF THE CALIBRATION CAPABILITY

The following steps represent the strategy recommended to determine the model parameters for HEC-1 in this study;

1. For each storm, the base flow and recession parameters (STRTQ, QRCSN, and RTIOR) are determined graphically. These parameters can not be estimated automatically and must be entered as input. These parameters are placed on the BF input card for each storm.

2. For each storm and each gage, the optimal estimates of all unknown unit hydrograph and loss rate parameters (TC, R, STRTL, and CNSTL) are determined using the automatic calibration feature.

3. A value of the constant loss rate, CNSTL, is estimated. A regional value of CNSTL based on all storms at all the gages is selected.

4. With CNSTL fixed at the selected value, the automatic calibration feature is again employed for all the storms at all the gages. A regional relationship for the initial loss, STRTL, is selected. (See Figure 5.1 )

5. With both loss rate parameters fixed the automatic calibration of the model is repeated.

6. Values of TC + R are selected for each basin. An average value of R/(TC + R) is selected for the region.

7. After all parameters are selected, the values are verified by simulating the response of the gaged basins to other storms not used in the calibration process.

## REGRESSION ANALYSIS APPROACH TO PARAMETER ESTIMATION (HEC-1, 1982)

Multiple linear regression techniques were used to correlate the unit hydrograph parameters with several

basin characteristics. Nonlinear relationships were investigated by transforming values logarithmically. Multiple regression analysis requires a computer program. Herein, the computer package MINITAB was used in the analysis.

The parameters TC and R were considered dependent variables and the basin characteristics were the independent variables. TC, R, (TC + R), and R/(TC + R) were analyzed, first, by considering several basin characteristics and, later, by reducing the number of independent variables until the "best" relationships (equations) were found.

The statistics describing the "goodness-of-fit" of the regression equation to the data are used in evaluating the analysis. These statistics are the coefficients of determination (both the adjusted and unadjusted), the partial determination coefficient, and the standard error of estimate. Their definitions are given below:

1. The adjusted and unadjusted multiple-determination coefficients ($R^2$) are a measure of the percent of variance in the dependent variable explained by the independent variable. The magnitude of these coefficients varies from 0 to 1. The closer to the value of 1, the greater the reliability is of the estimate.

2. The partial-determination coefficient ($r^2$) is a measure of the importance of an independent variable by determining the reduction in variance in the

dependent variable when the variable is included with the other independent variables.

3. The standard error of estimate ($S_e$) is the standard deviation of the difference between the observed dependent values and the values computed from the regression equation in the units of the dependent variable; therefore, it must be compared with the mean and the standard deviation of that variable.

For a more detailed description of multiple-regression analysis the reader is referred to a statistics book, such as Benjamin (1970, p.419). The general rule is to use the values of $R^2$, $R^2$ adjusted, and $S_e$ computed for each regression equation as a guide and select the equation with the fewest independent variables and the best values of $R^2$ and $S_e$.

# CHAPTER FOUR

# DATA

## PURPOSE AND SCOPE

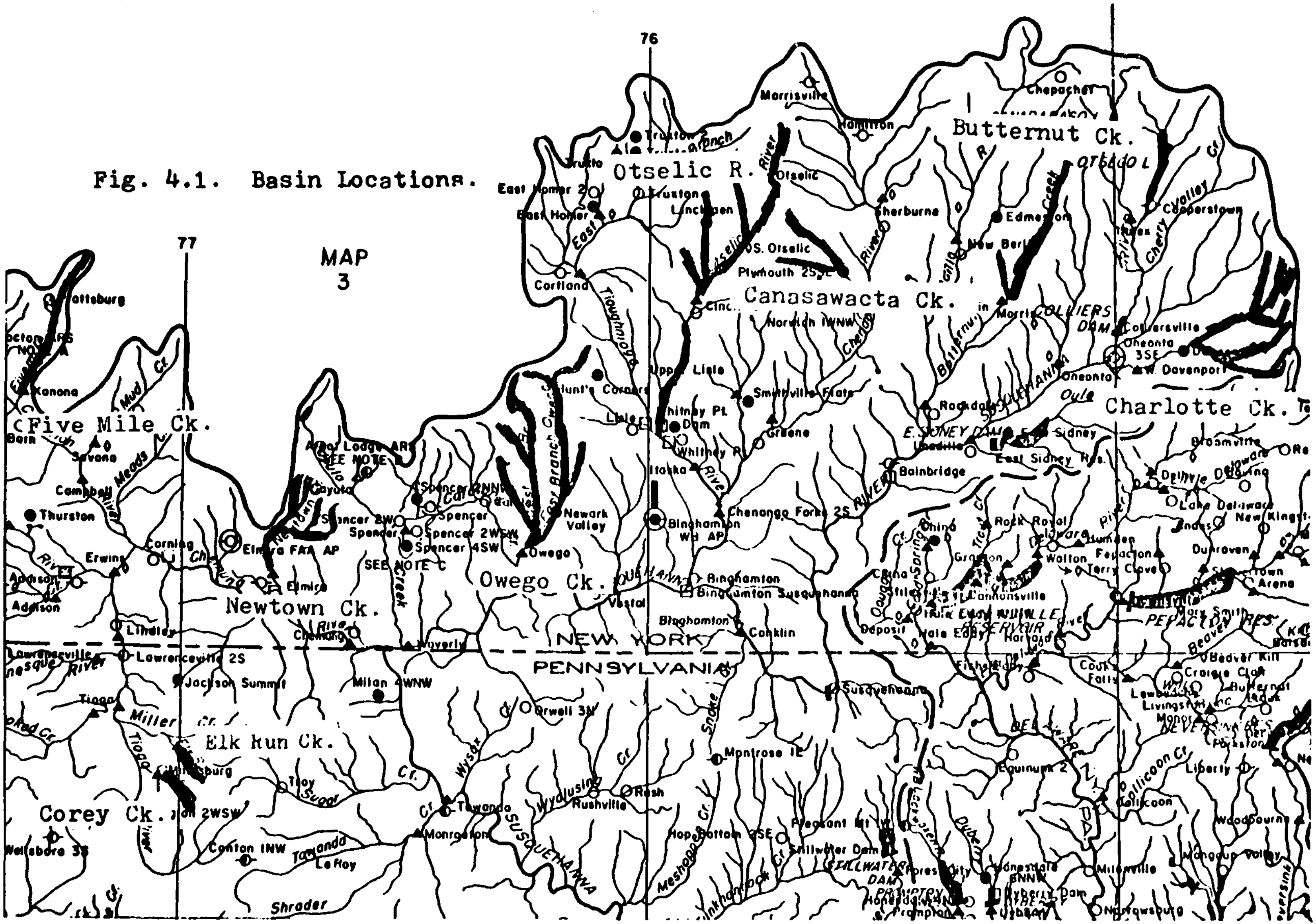
The purpose of this chapter is to present the data used in this study. The scope of this chapter is to display the basic data obtained from various sources after some refinement into a usable form for this analysis.

## BASIN CHARACTERISTICS

Nine watersheds in the Susquehanna and Chemung River basins were chosen for the present investigation. The watersheds were unregulated and possessed a U.S. Geological Survey (USGS) stream gage. The locations of these gages were taken as the outlets from the watersheds. The nine basins are henceforth referred to by the main channel watercourse. Their names are: Butternut Creek, Canasawacta Creek, Charlotte Creek, Corey Creek, Elk Run Creek, Five Mile Creek, Newtown Creek, Otselic River, and Owego Creek. All basins are in New York state except Corey Creek and Elk Run Creek, which are in Pennsylvania. Figure 4.1 depicts the basins used and their location with respect to one another.

The basin characteristics were measured from USGS Topographic Quadrangle maps ( 1:2400 ). Table 4.1 contains a tabular synopsis of the basin characteristics chosen

Fig. 4.1. Basin Locations.



| | DA | S | S2 | SWT | DD | L | LCM | SF1 | SF2 | ALT |
|---|---|---|---|---|---|---|---|---|---|---|
| Butternut Creek | 59.7 | 34.12 | 34.25 | 80.26 | 1.740 | 20.83 | 8.56 | 7.27 | .419 | 780 |
| Canasawacta Creek | 57.9 | 46.55 | 50.80 | 68.64 | 1.620 | 12.42 | 8.48 | 2.66 | .691 | 830 |
| Charlotte Creek | 167 | 34.60 | 36.83 | 67.58 | 1.633 | 24.77 | 15.15 | 3.67 | .589 | 1110 |
| Corey Creek | 12.2 | 135.48 | 164.12 | 106.39 | 1.422 | 5.38 | 3.03 | 2.37 | .733 | 1003 |
| Elk Run Creek | 10.2 | 105.23 | 115.52 | 123.89 | 1.188 | 6.74 | 4.43 | 4.45 | .535 | 850 |
| Five Mile Creek | 66.8 | 29.75 | 38.10 | 67.06 | 1.790 | 19.51 | 10.42 | 5.70 | .473 | 830 |
| Newtown Creek | 77.5 | 45.15 | 49.34 | 70.75 | 1.494 | 17.92 | 10.68 | 4.14 | .554 | 865 |
| Otselic River | 147 | 23.72 | 25.19 | 51.74 | 1.473 | 29.51 | 14.24 | 5.92 | .464 | 800 |
| Owego Creek | 185 | 29.22 | 32.34 | 54.38 | 1.809 | 30.57 | 15.95 | 5.05 | .502 | 1105 |

Table 4.1 Basin Characteristics.

for the present analysis on the basis of the review in Chapter 2. A definition of each term follows: (after Linsley (1955, p. 313))

DRAINAGE AREA (DA)--The area in square miles of the watershed above the stream gage. Any excess rainfall falling in the watershed would at some time pass through the gaging station. Rainfall falling outside of this area would drain into another watershed. These data were obtained from USGS Water Supply Papers.

SLOPE (S)--This is the average main channel slope in vertical feet per horizontal channel mile. Slopes were obtained by plotting the elevation of the map contours (in feet) versus the distance of the map contours from the gaging stations (in miles) and taking the straight line slope fitted by the least squares method. The steeper the slope the faster the basin will drain.

SLOPE 2(S2)--This is similar to slope (S) except the main channel is divided into two segments. Two straight lines are drawn representing a closer fit to the actual main channel profile. Slope 2 is a weighted average of these two segments.

S2 =((slope of segment 1)(horizontal length of segment 1) + (slope of segment 2)(horizontal length of segment 2))/(total main channel length)

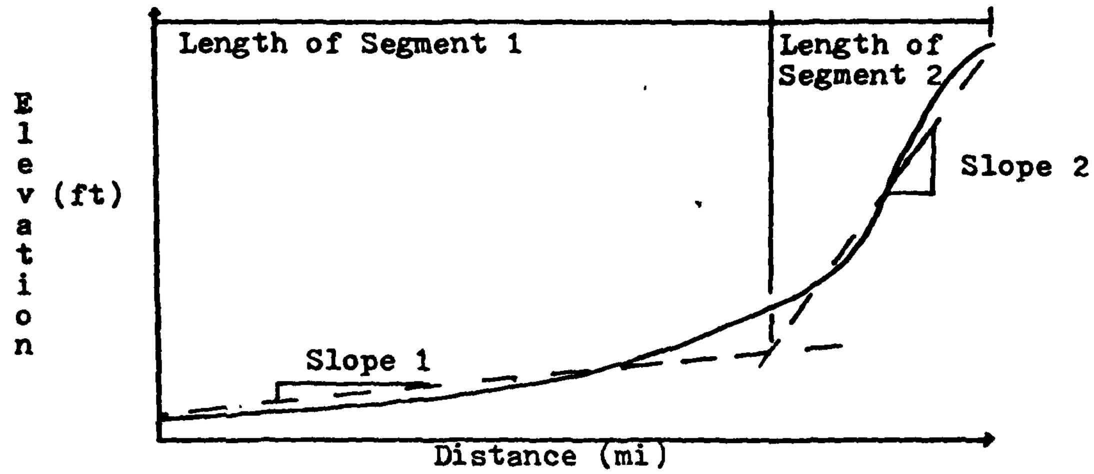



Figure 4.2. Slope2 Graphical Representation.

SLOPE WT (SWT)--This slope is a weighted slope intended to represent a better picture of the basin's slope characteristics by including the slope contribution of some of the tributary streams. Its feet is also listed in feet per mile.

DRAINAGE DENSITY (DD)--This is a measure of the amount of stream channel miles per basin square mile. It is obtained by measuring the cumulative length of every stream channel shown on the USGS topographic map. This cumulative length is divided by the drainage area. The higher the drainage density, the smaller distance any particle of excess rainfall must travel before entering a stream channel. This implies that the larger the DD value, the faster the basin will drain.

LENGTH OF THE MAIN CHANNEL (L)--This is a measure of the longest watercourse measured from the gaging station to the furtherest point of stream channel origination upstream.

L is measured in miles.

LENGTH TO THE BASIN CENTER OF MASS (LCM)--The center of mass is found by hanging a paper cut-out diagram of the drainage basin and marking off the vertical lines obtained from three different suspension points. The value for LCM is obtained by measuring the distance from the gaging station to the point on the main channel opposite the center of mass. LCM is measured in miles.

SHAPE FACTOR ONE (SF1)--This is a measure of the basin's shape. It is equal to the length of the main channel squared divided by the drainage area, i.e. $L^2/DA$.

SHAPE FACTOR TWO (SF2)--It is similar to SF1. It is the ratio between the diameter of a circle, the size of the drainage area (DA), and the length of the main channel (L), i.e. SF2 = DIA/L where $DIA = (4*DA/\pi)^{1/2}$. This term was proposed by Cruff and Rantz (1965).

ALTITUDE (ALT)--This is a measure of the vertical drop between the elevation at the main channel headwaters and the gaging station in feet.

## STORM/FLOOD DATA SELECTION

An effort was made to obtain 5-10 of the major flood events occurring in each basin since the record flooding which was produced by Hurricane Agnes (June 1972). There were several seasons for selecting events since the summer of 1972. First, it is desired to minimize the influences

of basin changes which either naturally occur or are caused by man over time. It was felt that a time period of ten to eleven years would be a reasonable length of time to minimize basin change effects. Second, results of studies prior to,or as a result of, Hurricane Agnes may be compared with the results of this work. The storm events for each basin are presented in Table 4.2. It should be noted that not all storm dates were taken after June 1972, because not enough major storms had occurred to provide a sufficiently wide data base to conduct the analysis. In addition, only events were selected which were free from any indication of snowmelt, ice jam, or difficulties involving the stream gaging stations. These problems are beyond the scope of this work.

## PRECIPITATION DATA

Precipitation data for the storm events in each basin were obtained from documents published by the National Weather Service. Basins were traced on paper from small scale maps. Locations of the rain gages in the vicinity of each basin were plotted on the tracing paper. The Thiessen Polygon method was used to divide up the basin. Planimeter measurements were made for all recording and nonrecording gages influencing the basin. The fraction of the basin contained in each polygon was recorded along with the rainfall amounts obtained from the Climatological Data

**Butternut Creek (NY)**
10-18-75 *
10-09-76
10-21-76
9-26-77
10-17-77

**Canasawacta Creek (NY)**
6-26-68
11-18-68
6-24-69
7-31-71 *
6-22/23-72
7-03-74

**Charlotte Creek (NY)**
6-29-73
12-21-73

**Corey Creek (PA)**
11-14-72
9-26-75
10-09-76 *
5-14-78
10-05-79
11-26-79
6-05-82

**Elk Run Creek (NY)**
10-22-70
11-14-72
9-26-75
10-09-76
10-20-76
5-14-78
8-06-78 *

**Five Mile Creek**
5-07-75
9-26-75
9-14-77
9-25-77 *

**Newtown Creek (NY)**
9-26-75
10-09-76 *
10-21-76
9-25-77
10-17-77
11-04-77
11-08-77
11-11-77
10-06-79
11-26-79
10-28-81 *

**Otselic River (NY)**
7-03-74
9-26-75
10-09-76 *
10-17-77
4-05-78

**Owego Creek (NY)**
11-08-72
9-26-75
10-09-76 *
9-25-77
10-17-77

<u>Total Storms</u>

52

Table 4.2

Storm Data (*)--Verification storms not used in model calibration.

and Hourly Precipitation Data (recording stations), documents of the National Weather Service. Appendix A contains the watershed rain gage locations and the Thiessen polygons.

## STREAMFLOW DATA

The streamflow data for each flood event at a particular gage were obtained through the Regional Office of the U.S.G.S. located in Ithaca, New York and the State office of the U.S.G.S. located in Harrisburg, Pennsylvania for the Pennsylvania stations. Stage data were obtained as height of the stream at particular times. For this study therefore, the stage data (FT) had to be converted to flow rates ($FT^3$/sec) by the use of the stream's rating curve. Flow rates were tabulated and retained for use as input for the HEC-1 calibration sequence.

The recession parameters, RTIOR and QRCSN were calculated as described in Chapter Three and retained as input for the computer model.

## INPUT FORMATTING AND DATA STRUCTURE FOR HEC-1

Input for the HEC-1 model is accomplished by creating a card deck organized in a certain structure and sequence for easy computer reading. Each card of eighty columns is set up in the following manner; columns 1 and 2 are used to identify the card type and purpose. Following columns 1 and 2 are ten data fields of eight columns each,

except the first field which is composed of only six columns. More detailed discussion of data organization may be found in HEC-1 manuals. A brief line-by-line explanation of a typical card deck as used in this study may be found in Appendix B. as well as the input card data information for all the storms used in this study.

## REGRESSION DATA FOR THE INITIAL LOSS PARAMETER (STRTL)

Because STRTL is storm dependent, a method of relating the STRTL values to the total amount of rain occurring in the 2, 3, 4, 5, 7, 8, and 10-day period prior to the storm was attempted. The statistical package MINITAB was used to perform regression analysis on the data. The data are displayed in Table 4.3. The reader may obtain further information on MINITAB by reading the MINITAB Reference Manual or by contacting MINITAB PROJECT, Statistics Department, 215 Pond Laboratory, Pennsylvania State University, University Park, PA 16802.

The values in columns two through eight were obtained by summing the products of the total rainfall recorded for each rain gage covering a portion of the basin and the fraction of the drainage area covered by that gage. The analysis of this data will be discussed in Chapter Five.

Day Period

| Basin/Storm | STRTL | D2 | D3 | D4 | D5 | D7 | D8 | D10 |
|---|---|---|---|---|---|---|---|---|
| Butternut | | | | | | | | |
| * 10-18-75 | | .31 | .31 | .87 | .87 | 1.25 | 1.25 | 1.25 |
| 10-09-76 | .53 | 0 | 0 | 0 | 0 | 0 | 0 | .20 |
| 10-21-76 | 0 | 0 | .01 | .01 | .40 | 1.29 | 1.29 | 1.29 |
| 9-26-77 | 0 | .73 | .73 | .75 | 1.14 | 3.19 | 3.19 | 5.40 |
| 10-17-77 | 0 | .80 | .8 | 1.01 | 1.01 | 1.73 | 1.73 | 2.02 |
| Canawacta | | | | | | | | |
| 6-26-68 | 1.09 | .09 | .09 | .09 | .16 | .38 | .38 | .40 |
| 11-18-68 | .26 | .36 | .36 | .61 | .72 | 1.47 | 1.47 | 1.96 |
| 6-24-69 | 2.26 | .44 | .51 | .51 | .51 | .81 | .81 | .85 |
| * 7-31-71 | | .03 | .88 | .88 | 1.6 | 1.6 | 1.6 | 2.67 |
| 6-22/23-72 | .08 | 0 | 0 | 0 | .78 | 1.67 | 1.67 | 1.67 |
| 7-03-74 | .98 | 0 | * | * | FOULED | * | * | * |
| Charlotte | | | | | | | | |
| 6-29-73 | 1.47 | .01 | .01 | .14 | .32 | .41 | .41 | .56 |
| 12-21-73 | .38 | .05 | .59 | 1.54 | 1.54 | 1.71 | 1.71 | 1.8 |
| Corey | | | | | | | | |
| 11-14-72 | .33 | .46 | .46 | .66 | .80 | .99 | .99 | .99 |
| 9-26-75 | .32 | .37 | .46 | .46 | .62 | .77 | .77 | .77 |
| 10-09-76 | 1.33 | 0 | 0 | 0 | 0 | 0 | 0 | .06 |
| 5-11-78 | .56 | 0 | 0 | .21 | .33 | .33 | .42 | .87 |
| * 10-05-79 | | .69 | 1.14 | 1.18 | 1.18 | 2.02 | 2.02 | 2.02 |
| 11-26-79 | .14 | .76 | .76 | .76 | .77 | .77 | .77 | .77 |
| 6-05-82 | .10 | 1.11 | 1.11 | 1.78 | 1.79 | * | * | * |
| Elk Run | | | | | | | | |
| 10-22-70 | 1.01 | 0 | 0 | 0 | .09 | .55 | .55 | 1.29 |
| 11-14-72 | .39 | 0 | 0 | 0 | 1.18 | 2.28 | 2.28 | 2.28 |
| 9-26-75 | .01 | .45 | .7 | .7 | .93 | 1.05 | 1.05 | 1.05 |
| 12-09-76 | 1.45 | 0 | 0 | 0 | 0 | 0 | 0 | .12 |
| 10-20-76 | .69 | 0 | 0 | 0 | 0 | .29 | .29 | .29 |
| 5-14-78 | .05 | 0 | 0 | 0 | .78 | .78 | .78 | 1.55 |
| * 8-06-78 | | 2. | 2. | 2. | 2.4 | 2.75 | 2.75 | 3.3 |

Table 4.3
Previous Rainfall Amounts

| | | Day Period | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Basin/Storm | STRTL | D2 | D3 | D4 | D5 | D7 | D8 | D10 |
| **Five Mile** | | | | | | | | |
| 5-07-75 | 0 | .1 | * | Fouled | * | * | * | * |
| 9-26-75 | .92 | .6 | .9 | .9 | .9 | 1.1 | 1.1 | 1.1 |
| 9-14-77 | 1.34 | .01 | .01 | .01 | .01 | .01 | .18 | .27 |
| * 9-25-77 | | .01 | .01 | 2.09 | 2.19 | 3.59 | 4.6 | 5.34 |
| **Newtown** | | | | | | | | |
| 9-26-75 | .01 | .81 | .81 | .84 | .94 | 1.43 | 1.43 | 1.43 |
| *10-09-76 | | 0 | 0 | 0 | 0 | 0 | 0 | .1 |
| 10-21-76 | .36 | 0 | o | 0 | .05 | .26 | .27 | .27 |
| 9-25-77 | .66 | .04 | .09 | .46 | .80 | 1.69 | 2.48 | 3.9 |
| 11-04-77 | .65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-08-77 | .13 | .12 | 1.64 | 2.05 | 2.05 | 2.05 | 2.05 | 2.05 |
| 11-11-77 | .19 | .54 | 1.09 | 1.09 | 1.85 | 3.02 | 3.02 | 3.02 |
| 10-17-77 | .01 | .25 | .25 | .26 | .27 | .76 | .76 | .93 |
| 10-06-79 | .96 | .52 | .52 | .52 | .52 | 1.44 | 1.44 | 1.44 |
| 11-26-79 | .39 | .3 | .32 | .4 | .4 | .4 | .4 | .43 |
| *10-28-81 | | .14 | .28 | .28 | .28 | .4 | .56 | .57 |
| **Ostelic** | | | | | | | | |
| 7-03-74 | 2.33 | .11 | .16 | .47 | .47 | 1.56 | 1.56 | 1.56 |
| 9-26-75 | 1.3 | .24 | .24 | .49 | .49 | .91 | .98 | .98 |
| *10-09-76 | | 0 | 0 | 0 | 0 | 0 | 0 | .13 |
| 10-17-77 | .04 | .63 | .63 | .63 | .85 | 1.34 | 1.82 | 2.02 |
| 4-05-78 | 0 | .01 | .1 | .26 | .26 | .28 | .48 | 1.26 |
| **Owego** | | | | | | | | |
| 11-08-72 | .61 | .01 | .07 | .08 | .93 | .99 | .99 | 1.6 |
| 9-26-75 | .29 | .46 | .46 | .63 | .78 | 1.15 | 1.2 | 1.2 |
| *10-09-76 | | .03 | .03 | .03 | .03 | .03 | .03 | .13 |
| 9-25-77 | 0 | .03 | .1 | 1.09 | 1.45 | 2.28 | 4.0 | 5.25 |
| 10-17-77 | .06 | .3 | .3 | .44 | .45 | 1.1 | 1.18 | 1.37 |

Table 4.3. (Continued)
Previous Rainfall Amounts

# CHAPTER FIVE

# RESULTS AND DISCUSSION

## PURPOSE AND SCOPE

The purpose of this chapter is to present the results of the calibration effort for the basins and storms selected as the control group; these comprise selection of the unit hydrograph and regional loss rate parameters, determination of regression relationships, and verification of the results using uncontaminated flood events. The scope of this chapter is to display the results and to discuss the findings in relation to an earlier study.

## MODEL CALIBRATION FOR EACH BASIN

The 'best' fit values of the four model parameters for each event are presented in Table 5.1. Each event was initially optimized using the model's default values. From the initial results the starting values of the parameters were manipulated until the 'best' fit choices produced the 'best' statistical summary results. These summaries as well as other 'best' fit results may be found in Appendix C.

Once the optimized parameters were determined for the control storms, the parameter for the constant loss rate, CNSTL, was averaged for each basin. For certain

Table 5.1.

"Best-Fit" Values Optimization Results.

| Basin/Storm | TC | R | STRTL | CNSTL |
|---|---|---|---|---|
| **Butternut Creek** | | | | |
| 10-10-76 | 13.83 | 6.24 | .53 | .05 |
| 10-21-76 | 10.98 | 14.06 | 0 | 0 |
| 9-26-77 | 9.93 | 10.52 | 0 | 0 |
| 10-17-77 | 14.77 | 4.53 | 0 | 0 |
| **Canasawacta Creek** | | | | |
| 6-26-68 | 4.25 | 9.69 | 1.23 | .06 |
| 11-18-68 | 2.25 | 10.61 | 0 | 0 |
| 6-24-69 | 1.83 | 12.37 | 2.0 | .20 |
| 6-22/23-72 | 3.33 | 7.94 | .99 | 01 |
| 7-03-74 | 6.13 | 4.10 | .9 | .07 |
| **Charlotte Creek** | | | | |
| 6-29-73 | 14.61 | 20.90 | .92 | .09 |
| 12-21-73 | 4.21 | 15.21 | .50 | .04 |
| **Corey Creek** | | | | |
| 11-14-72 | 1.62 | 10.39 | .30 | .12 |
| 9-26-75 | 2.27 | 2.71 | .39 | .08 |
| 10-09-76 | 3.97 | 4.73 | 1.62 | .15 |
| 5-14-78 | 1.03 | 6.94 | .28 | .15 |
| 11-26-79 | 2.60 | 3.73 | .22 | .09 |
| 6-05-82 | 1.05 | 11.96 | .04 | .12 |
| **Elk Run Creek** | | | | |
| 10-22-70 | 1.07 | 5.95 | 1.25 | .16 |
| 11-14-72 | 1.50 | 8.54 | .28 | .14 |
| 9-26-75 | 1.03 | 4.12 | .80 | .10 |
| 10-04-76 | 4.83 | 1.69 | .62 | .07 |
| 10-20-76 | 1.92 | 3.69 | .83 | .07 |
| 5-14-78 | 1.06 | 2.36 | .08 | .03 |

Table 5.1 Continued

"Best-Fit" Values Optimization Results.

| Basin/Storm | TC | R | STRTL | CNSTL |
|---|---|---|---|---|
| Five Mile Creek | | | | |
| 5-07-75 | 14.73 | 25.44 | .2 | .02 |
| 9-26-75 | 4.27 | 26.76 | .89 | .02 |
| 9-14-77 | 9.65 | 20.35 | 1.09 | .11 |
| Newtown Creek | | | | |
| 9-26-75 | 12.48 | 20 58 | .03 | .05 |
| 10-21-76 | 11.01 | 4.84 | .36 | .07 |
| 9-25-77 | 10.42 | 13.59 | .66 | .07 |
| 10-17-77 | 8.31 | 16.02 | .01 | .06 |
| 11-04-77 | 9.18 | 11.90 | .65 | .07 |
| 11-08-77 | 8.41 | 14.53 | .13 | .02 |
| 11-11-77 | 7.86 | 13.48 | .19 | .02 |
| 10-06-79 | 2.64 | 18.50 | .72 | .14 |
| 11-26-79 | 5.79 | 17.17 | .04 | .11 |
| Ostelic River | | | | |
| 7-03-74 | 10.37 | 14.26 | 2.0 | .15 |
| 9-26-75 | 6.14 | 25.69 | 1.27 | .06 |
| 10-17-77 | 15.46 | 29.53 | .01 | .05 |
| 4-05-78 | 6.32 | 26.52 | .05 | .01 |
| Owego Creek | | | | |
| 11-08-72 | 8.35 | 18.94 | .16 | .06 |
| 9-26-75 | 7.09 | 15.23 | .78 | .03 |
| 9-25-77 | 6.15 | 17.78 | .21 | .03 |
| 10-17-77 | 10.12 | 17.28 | .12 | .03 |

values within the observed range of this parameter (around its average) and depending on its performance the basin value of CNSTL selected for each basin is displayed in Table 5.2.

Because of the unique structures of the Butternut and Five Mile Creeks, their values do not appear to fit into the general pattern of increasing CNSTL values as one proceeds southwestwardly from the Upper Susquehanna region. Butternut Creek has a rather large value for SWT (80.26 ft/mi) and the largest value for SF1 (7.27) implying a long,narrow, steep-sided basin. Such a basin would not allow as much water to be intercepted/infiltrated as the other basins. On the other hand, a casual observation of the Five Mile Creek basin on a topographic map shows a great deal of swamp area. This condition would retard the flood wave; however, less rainfall would be lost due to the already wet soil condition.

Holding the parameter CNSTL constant for each basin, the other three parameters were optimized. The values of the initial loss parameter, STRTL, were regressed against the amount of total precipitation falling at different time periods preceeding the storm. The best derived regression equation was STRTL = 0.861 - 0.504 * D5, where D5 is the total amount of rainfall occurring five days prior to the beginning of the storm. See Figure 5.1 for a plot of STRTL vs D5 for all of the control storms. This equation has an unadjusted multiple-determination coefficient,

Table 5.2.

Basin Averaged Constant Loss Rates (CNSTL).

| | CNSTL (inches/hour) |
|---|---|
| Butternut Creek | 0.00 |
| Canasawacta Creek | 0.05 |
| Charlotte Creek | 0.05 |
| Corey Creek | 0.10 |
| Elk Run Creek | 0.10 |
| Five Mile Creek | 0.03 |
| Newtown Creek | 0.07 |
| Ostelic River | 0.05 |
| Owego Creek | 0.05 |

$R^2$, equal to .192.

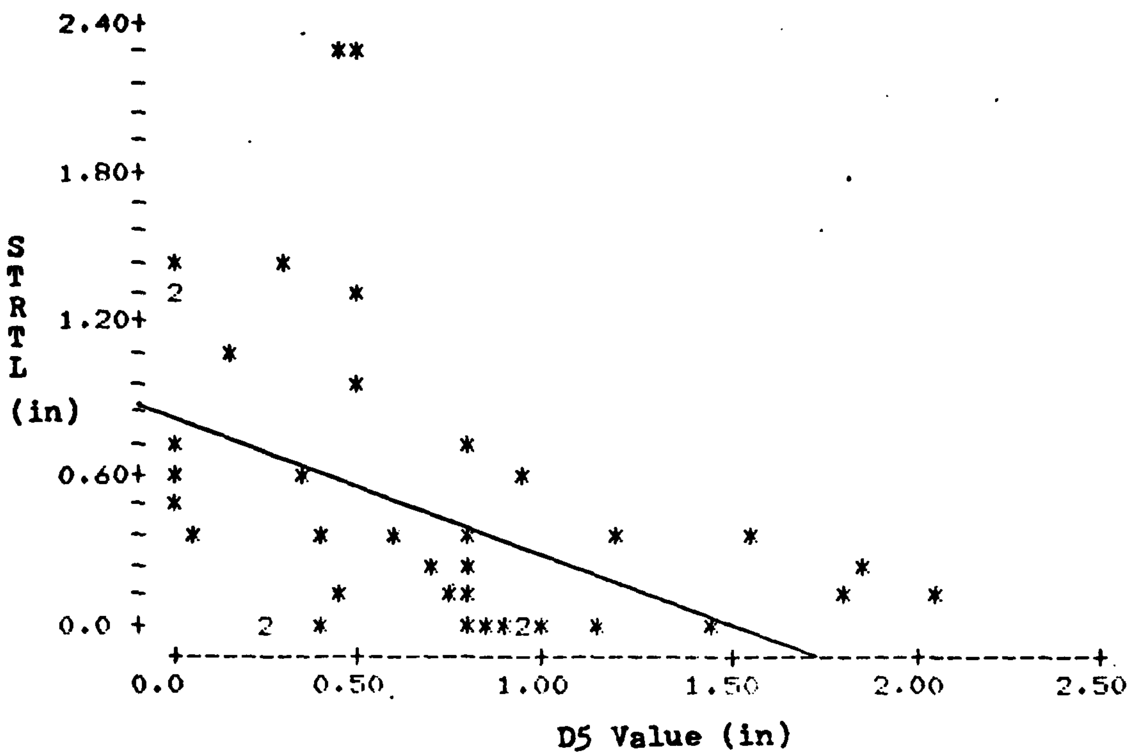



Figure 5.1. Regression Equation for STRTL Plot.

Although the coefficient is not as high as desired, the D5 term gave the best correlation. The control storms plotted below the line in Figure 5.1 will give conservative forecasts. This means higher computed peaks than the observed peaks. The STRTL term is rather sensitive (see Sensitivity Analysis section, later), however, in the absence of any other method,this approach was used.

The values for STRTL were predicted by means of this regression equation. Each storm was then optimized for the TC and R parameters. The final parameter values for

the control storms are listed in Table 5.3.

These values were used in computing and comparing the verification storm group hydrographs with the observed flood hydrographs. The statistical results are presented in Appendix D for the verification storms.

## COMPARISON WITH PARAMETERS DETERMINED PRIOR TO HURRICANE AGNES (1972)

In June 1970 the Susquehanna River Basin Study Coordinating Committee published an extensive work on the Susquehanna basin. Appendix D (Hydrology) of that study contained the Clark unit hydrograph parameters for several gaged basins, obtained on the basis of a similar computer program developed by the Hydrologic Engineering Center, U S. Army Engineer District, Sacramento, CA, (now HEC is located in Davis, CA).

The data base used in the study consisted of four major flood events. Basin average rainfall was determined by Thiessen polygons. Two or four-hour unit hydrographs were developed depending on the drainage area of the basin. The TC and R parameter values are presented in Table 5.4. Not all of the basins could be compared with the current results because some stream gages have been relocated since the publication of the study. Table 5.4 shows a very good comparison between most of the terms. The values of R for Charlotte and Five Mile Creeks are not in good

Table 5.3.

Derived Parameters.

| Basin | TC | R (hours) |
|---|---|---|
| Butternut Creek | 11.66 | 6.76 |
| Canasawacta Creek | 8.65 | 8.59 |
| Charlotte Creek | 11.68 | 27.70 |
| Corey Creek | 1.90 | 8.27 |
| Elk Run Creek | 2.02 | 8.13 |
| Five Mile Creek | 7.47 | 46.12 |
| Newtown Creek | 9.00 | 14.46 |
| Ostelic River | 9.80 | 36.13 |
| Owego Creek | 9.35 | 13.83 |

agreement. A possible explanation for the Charlotte Creek discrepancy is the fact that only two storms meeting the established criteria in the past fifteen years could be found for this basin. The expected value variance of any derived parameter based on only two data points is very great. Therefore, one would not expect the values of the two works to be very close.

The discrepancy of the R values for Five Mile Creek could be related to the goodness-of-fit of the storms selected for this study. Looking at the plots of the 'best' fit computed flow with the observed flow, the reader will notice that the computed hydrograph had a rather difficult time matching the observed hydrograph. Whether the rain gage in the middle of the basin failed to provide accurate data or the U.S.G.S. gaging station measurements were fouled by mechanical defects is not clear. The author is inclined to doubt the observed hydrograph measurement because of the peculiar combination of spike and round portions.

| | Study(Jun 70) | | Present Results | |
|---|---|---|---|---|
| | TC | R | TC | R |
| Canasawacta Ck. | 2.03 | 11.04 | 8.65 | 8.59 |
| Charlotte Ck. | 11.83 | 14.79 | 11.68 | 27.70 |
| Five Mile Creek | 5.50 | 19.00 | 7.47 | 46.12 |
| Newtown Creek | 9.71 | 18.39 | 9.00 | 14.46 |
| Owego Creek | 10.10 | 11.82 | 9.35 | 13.83 |

Table 5.4.
Parameter Comparison with Previous Study

## SENSITIVITY ANALYSIS OF PARAMETERS

A sensitivity analysis was performed on a selected storm whose 'best' fit results initially yielded a very good statistical summary. The storm selected from the control group was the Newtown Creek 11-04-77 storm. Holding the other three parameters constant, the parameter TC was decreased and increased 5 and 10%. The same was done for the parameter R. The loss rate parameters are not normally known to such a high degree of accuracy. Therefore, the loss rate parameters were not varied by 5 and 10% because the results were not significantly different. For the initial loss rate parameter, STRTL, the value was decreased and increased .1 and .2 inches to show a better variability. The parameter for constant loss rate, CNSTL, was varied by .02 and .04 inches/hour each way. These variations are reasonable for any basin under investigation. The results are displayed in Table 5.5.

The reader is directed to the Peak Flow column. The Peak Flow percent was not very sensitive to variations in the TC and R terms. The most change was about 6% between the computed and observed peaks. Variations in the normal range of expected values of the loss parameters are a different story. A decrease of STRTL of .2 inch caused an overestimation of the peak by 14%. While a .04 inch/hour decrease or increase in the CNSTL produced approximately a 40% change in both directions.

| Adjustments | Sum of Flows Diff. | Equiv Depth Diff. | Mean Flow Diff | Time To C.M. Diff | Lag C.M. to C.M. | % Peak Flow | Time of Peak | AVG % ABS Error | OF |
|---|---|---|---|---|---|---|---|---|---|
| Control | -3.73 | -.031 | -23 | -.96 | -5.37 | .60 | 0. | 12.61 | 61 |
| TC -10% | 3.46 | .018 | 34 | -.17 | -1.84 | 2.87 | -1 | 10.77 | 88 |
| -5% | 2.61 | .013 | 26 | -.04 | -.39 | 1.33 | -1 | 10.01 | 68 |
| +5% | .84 | .004 | 8 | .23 | 2.41 | -.45 | 0. | 9.36 | 63 |
| +10% | -.06 | 0. | -1 | .35 | 3.77 | -1.8 | 0. | 10.06 | 80 |
| R -10% | 6.81 | .035 | 67 | -.04 | -.44 | 6.78 | 0. | 11.74 | 104 |
| -5% | 4.21 | .022 | 42 | .03 | .33 | 3.59 | 0. | 10.46 | 74 |
| +5% | -4.64 | -.039 | -28 | -.72 | -4.02 | -2.29 | 0. | 11.80 | 60 |
| +10% | -2.95 | -.015 | -29 | .21 | 2.22 | -4.98 | 0. | 9.62 | 77 |
| STRTL -.2 | 27.45 | .141 | 271 | -.75 | -7.09 | 14.23 | -1. | 46.17 | 299 |
| -.1 | 14.60 | .075 | 144 | -.37 | -3.72 | 7.34 | 0. | 24.84 | 163 |
| +.1 | -11.10 | -.057 | -110 | .7 | 8.12 | -6.18 | 0. | 22.21 | 139 |
| +.2 | -17.61 | -.09 | -174 | 1.02 | 12.52 | -9.93 | 0. | 31.56 | 208 |
| CNSTL-.04 | 42.20 | .217 | 417 | .06 | .62 | 38.5 | 0. | 42.77 | 536 |
| -.02 | 21.97 | .113 | 217 | .07 | .78 | 19.55 | 0. | 24.4 | 282 |
| +.02 | -18.48 | -.095 | -182 | .13 | 1.37 | -18.35 | 0. | 19.05 | 243 |
| +.04 | -38.70 | -.199 | -387 | .18 | 1.97 | -37.3 | 0. | 38.10 | 496 |

Initial Parameter Values were; TC = 9.18 STRTL = .65

R = 11.90 CNST = .07

(-) OBS > computed

(+) OBS < computed

Newtown Creek
11-04-77

Table 5.5.

Sensitivity Results

The results of the analysis show that the loss parameters are the most sensitive and must be estimated accurately to give reasonable results.

The reader may recall the discussion in Chapter Three concerning the optimized solutions of HEC-1 not being the global solution. This point is reflected in this analysis where a 5% increase in TC produced a better fit than the original controlled parameter storm.

REGRESSION ANALYSIS OF THE PARAMETERS TC AND R

Various combinations of the basin characteristics listed in Table 4. were tried. The only restriction placed on the combinations was that only one slope value and only one shape factor were permitted in any one combination. Combinations of the characteristics as well as their log values were evaluated. Table 5.6 lists the top combinations of each type along with the statistical coefficients. Table 5.7 lists some of the characteristic combinations used.

| | $R^2$ | $R^2$-ADJ | Standard Deviation |
|---|---|---|---|
| $TC = 7{,}942.63(DA)^{.66}/(ALT)^{1.44}$ | .910 | .879 | 0.2474 |
| $TC = 450.34/(S2)^{1.08}$ | .878 | .861 | 0.2659 |
| $TC = 5.93\ (DA/S)^{.412}$ | .871 | .853 | 0.2736 |
| $TC = 1.73(L\sqrt{DA/S})$ | .861 | .842 | 0.2836 |
| $TC = 3.60\ (L/\sqrt{S})^{.716}$ | .847 | .825 | 0.2980 |

Table 5.6. Highest Correlated Regression Equations.

| | $R^2$ | $R^2$-ADJ | Standard Deviation |
|---|---|---|---|
| $TC{+}R = 626.41/(S)^{.87}$ | .731 | .693 | 0.3365 |
| $TC{+}R=14.15(L/\sqrt{S})^{.549}$ | .686 | .641 | 0.3638 |
| $TC{+}R=20.91(DA/S)^{.312}$ | .686 | .641 | 0.3639 |
| $TC{+}R=8.25(L\sqrt{DA/S})^{.35}$ | .677 | .630 | 0.3693 |
| $TC{+}R=15.18(L/\sqrt{SWT})^{.653}$ | .667 | .619 | 0.3748 |
| $TC{+}R=507.76/(S2)^{.794}$ | .658 | .610 | 0.3795 |

Table 5.6.

Highest Correlated Regression Equations
(Continued)

| | DA/S | DA/SWT | $L\ LCM/\sqrt{S}$ | $L\sqrt{DA/S}$ | $L/\sqrt{S}$ | $L/\sqrt{SWT}$ |
|---|---|---|---|---|---|---|
| Butternut Ck. | 1.75 | .74 | 30.53 | 27.55 | 3.57 | 2.33 |
| Canasawacta Ck. | 1.24 | .84 | 15.44 | 13.85 | 1.82 | 1.50 |
| Charlotte Ck. | 4.83 | 2.47 | 63.80 | 54.42 | 4.21 | 3.01 |
| Corey Ck. | .09 | .11 | 1.4 | 1.61 | .46 | .52 |
| Elk Run Ck. | .10 | .08 | 2.91 | 2.10 | .66 | .59 |
| Five Mile Ck. | 2.25 | 1.00 | 37.27 | 29.23 | 3.58 | 2.38 |
| Newtown Ck. | 1.72 | 1.10 | 28.48 | 23.48 | 2.67 | 2.13 |
| Ostelic Ck. | 6.2 | 2.84 | 17.72 | 73.46 | 6.06 | 4.10 |
| Owego Ck. | 6.33 | 3.40 | 90.20 | 76.92 | 5.66 | 4.15 |

Table 5.7.

Basin Parameter Combinations

The first equation in each group in the table has the highest correlation coefficients, lowest variance, and least number of parameters. The parameters relating best to the Clark unit hydrograph parameters TC and R were found to be the drainage area (DA), altitude difference (ALT), and the main channel slope (S). The shape factors were found to be highly related to the other terms. They were eliminated without exception in every stepwise regression operation. The term S2 faired better in the TC group than the S term. The opposite is true in the TC + R group. However, the difference between them is not great and does not warrant the additional effort of deriving S2.

## AUTOMATIC CALIBRATION RESULTS

In Chapter Three under the section "Calibration of Model Parameters", it was mentioned that the optimization technique employed by HEC-1 does not guarantee that the parameters derived are global solutions. An example of this is displayed in Figures 5.2 and 5.3. Figure 5.2 is the graphical results obtained using the HEC-1 initial parameters as starting points. Figures 5.3 is the final results used in this analysis for the Butternut Creek (9-26-77) storm.

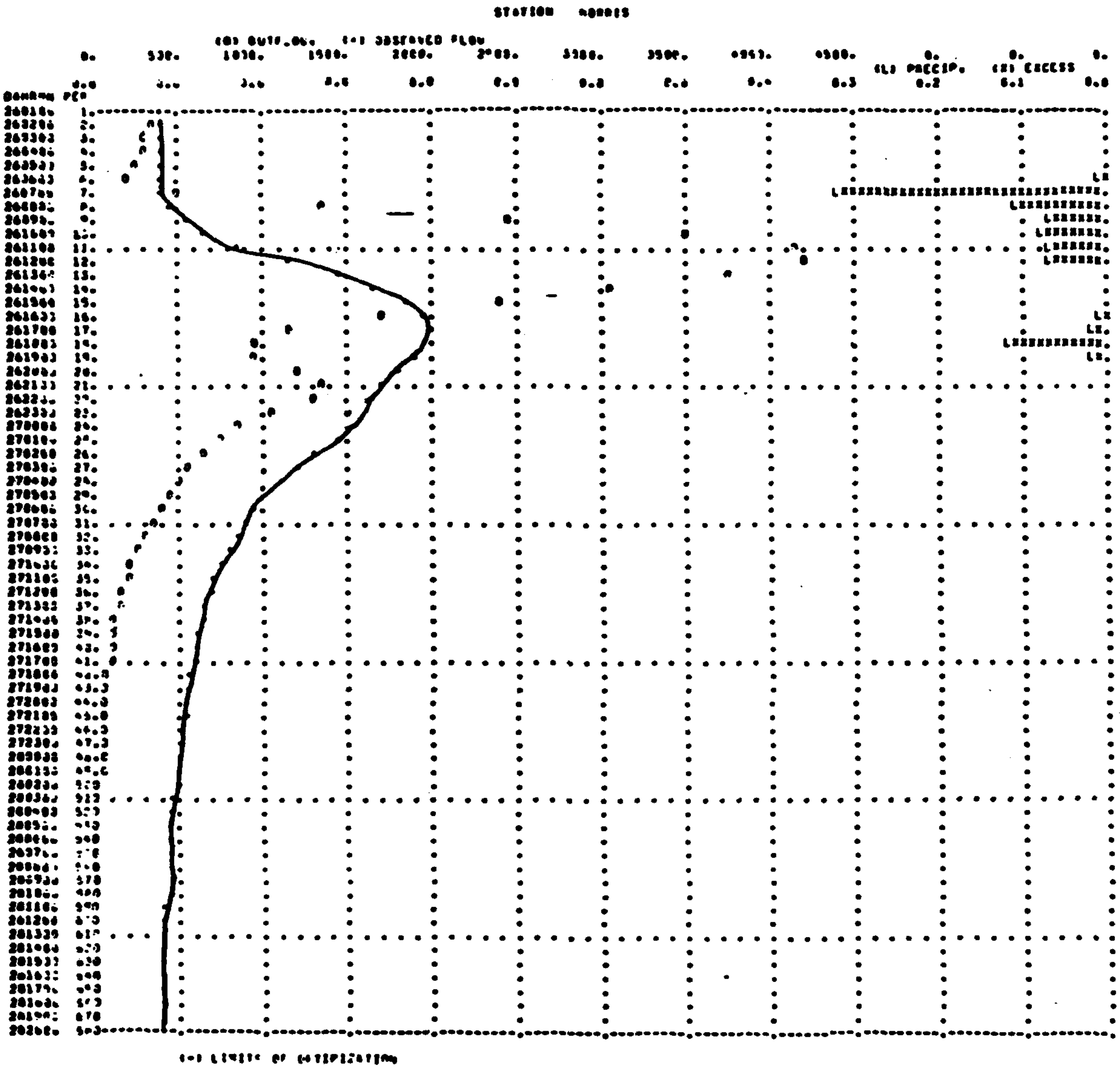


Figure 5.2. Initial Optimization Results.

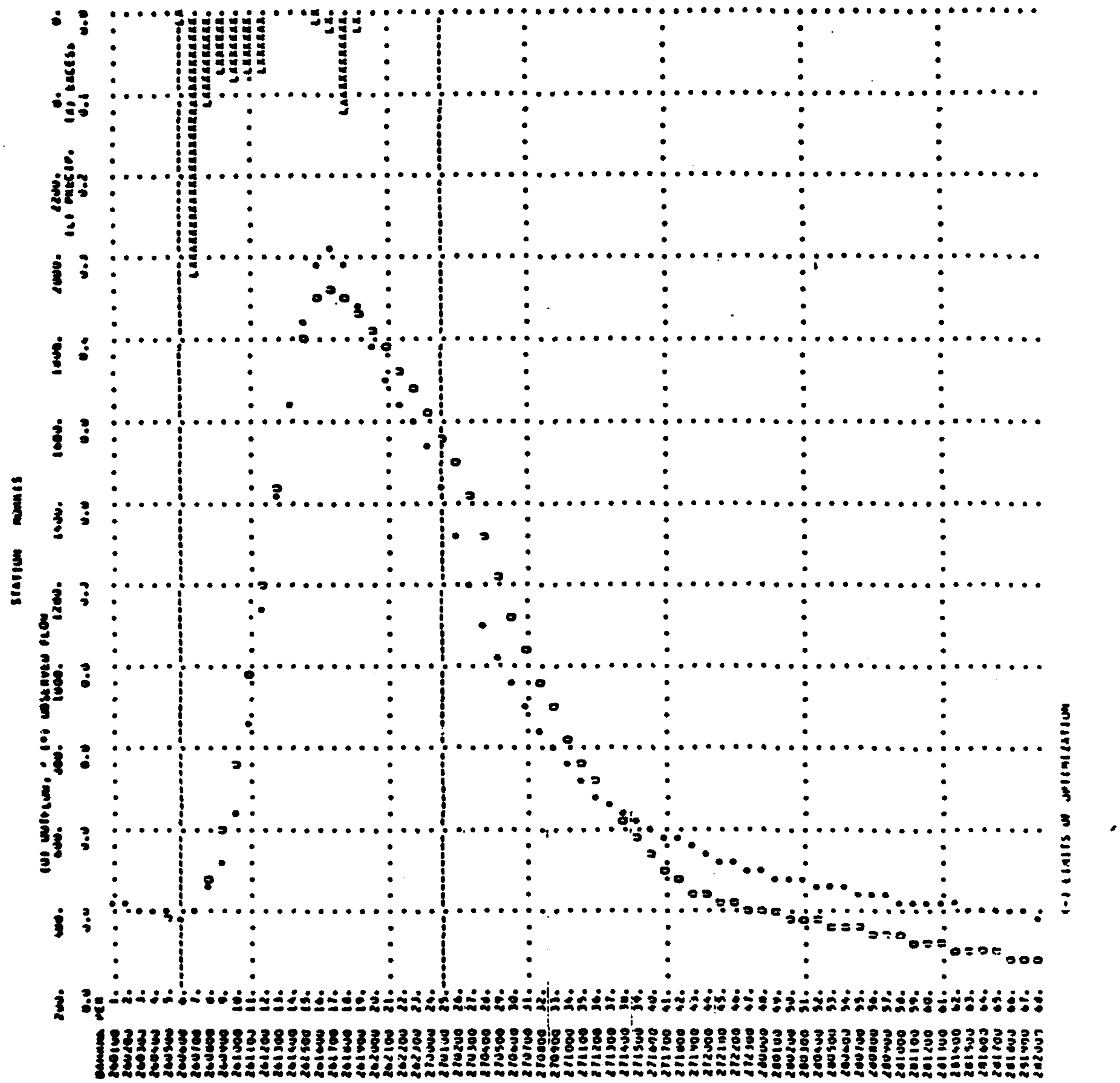


Figure 5.3. Finial Optimization Results.

# CHAPTER SIX

## SUMMARY AND CONCLUSIONS

McSparran (1968, p.937) found in his study of 32 watersheds varying in drainage area from 2 to 210 square miles in Pennsylvania that relating hydrograph parameters to watershed characteristics is not an easy task. He found nonlinearity factors present in every storm, adjusting and altering the parameters. As a result he felt that the unit hydrograph method was not as accurate as it should be. He stated that major floods would be underpredicted and on the average the observed peaks would be underpredicted by 22% using the Snyder unit hydrograph method. Yet by using the Soil Conservation Service (SCS) method the average peaks were predicted 51% too high.

On the other hand, Heerdegen (1974, p.1143) concluded with a resounding "affirmative" to his article's question-title, "Unit Hydrograph: A Satisfactory Model of Watershed Response?" Sixty measured parameters for each of the sixteen watersheds in Pennsylvania were used in analyzing ninety-six flood events. Five parameters were eventually selected as the most influential for his area. However, they were not constant from area to area. In his study he concluded that the storm variable of precipitation duration and volume of precipitation excess are major factors in flood hydrograph responses.

## SOURCES OF ERROR

Whenever one attempts to measure a physical property in nature, there is some error. Rain gages and streamflow gages leave a lot to be desired when it comes to accurate measurements. Rain gages are point measuring instruments and they hardly ever represent the amount of rainfall deposited on a basin accurately. In some cases rain gages at a great distance from the basins had to be used, because the local data were fouled or not reported.

The choice of model is a source of error. Every model makes some simplifying assumptions for ease of computation, cost, or speed. HEC-1 is a lumped or bulk parameter model. It groups all of the irregularities and unique features of a basin into one big box. Richards (1955, p.110) presented nine factors affecting runoff. Some of these factors, such as moving storms and intensity variations, are ignored by HEC-1.

In the absence of specific information, a synthetic time area curve (supplied by HEC-1) was made to create a translation hydrograph for each basin. The basins varied in many sizes and shapes and forcing the time-area curve to fit all the basins seems unrealistic.

The type of optimization routine, i.e. univariant search technique, does not guarantee the results to be a global solution and indeed the user of the model must

be aware of its hazards. Picking new starting points and adjusting the parameters to get a better fit is sometimes more luck than skill.

The loss rate selection is a major source of error. The inability to obtain a consistent and reliable STRTL predicting device greatly influenced the final results and future applications of this study. Bulk loss rates are perhaps better suited for large areas.

Selection of the Clark method to derive flood hydrographs affected the results. The application of a linear numerical model, although frequently used in government and private studies, to a nonlinear problem induces error.

Are the areas of interest, i.e. the Upper Susquehanna and Chemung River Basins, compatable? The nine stream basins are supposed to be hydrologically similar. Are they? What does hydrologically similar mean? This author concluded that the basins are fairly hydrologically similar because the slopes and valley structures appear to be consistent among the nine basins and most major storms track across both river basins. What basin or climatic factors were not included which would have improved the correlation between the model parameters and the basin characteristics? Chow (1964, p.27-104) states that some areas are just not adequate for unit hydrographs.

The unit hydrograph assumptions of time invariance and linear runoff responses are not strictly valid in

real life. Basin characteristics do change with time, e.g. land cover and seasonal changes influence loss rates.

The selection of storms will affect the results. Although the storms are the largest occurring in the last ten to fifteen years (unaffected by snow), most are not to be considered major storms. Sokolov (1976, p.199) quoted U.S. Army Corps of Engineers' studies when they said that in the majority of the basins studied the peak ordinates of the unit hydrographs derived from a major flood are generally significantly greater than those derived from data from a minor flood. Those studies stated that unit hydrograph peak ordinates from major floods were twenty-five to fifty percent greater than those derived from minor floods. Therefore, one would expect the results obtained in the application of the regression relationships to be somewhat underpredictive, i.e. on the conservative side.

The storms selected cover several seasons from early April until December. Although Heerdegen (1968, p.1143) found no significant seasonal differentiation in the unit hydrograph at the five percent level, Sherman (1932, p.504) felt that unit hydrographs should be seasonally segregated.

## LIMITS OF APPLICATION

The data were obtained from streams and rain gages in south central New York and north central Pennsylvania and they should be applied in that area. With the exception

of Five Mile Creek, the streams appear to be free from a great deal of valley storage and swampy areas. The results were obtained without snowmelt or ice jams affecting the outlet flow rate. Therefore, the results should apply primarily to summer and fall seasons.

## AREAS IN NEED OF FUTURE INVESTIGATION

The lack of adequate soil moisture data hindered the proper calibration of the parameter STRTL. Without adequate or reasonable loss rate parameter values, the model will not serve as a reliable predictive tool.

## SUMMARY

By using the Flood Hydrograph, HEC-1, computer package, the Clark unit hydrograph, and the initial/uniform loss rate, parameters were determined for nine watersheds in the Chemung and Upper Susquehanna River basins. Fifty-two storms were used in the analysis on the watersheds which range in drainage areas from 10.2 to 185 square miles. Regression equations predicting the time of concentration, TC, and the term TC + R were derived.

## CONCLUSIONS

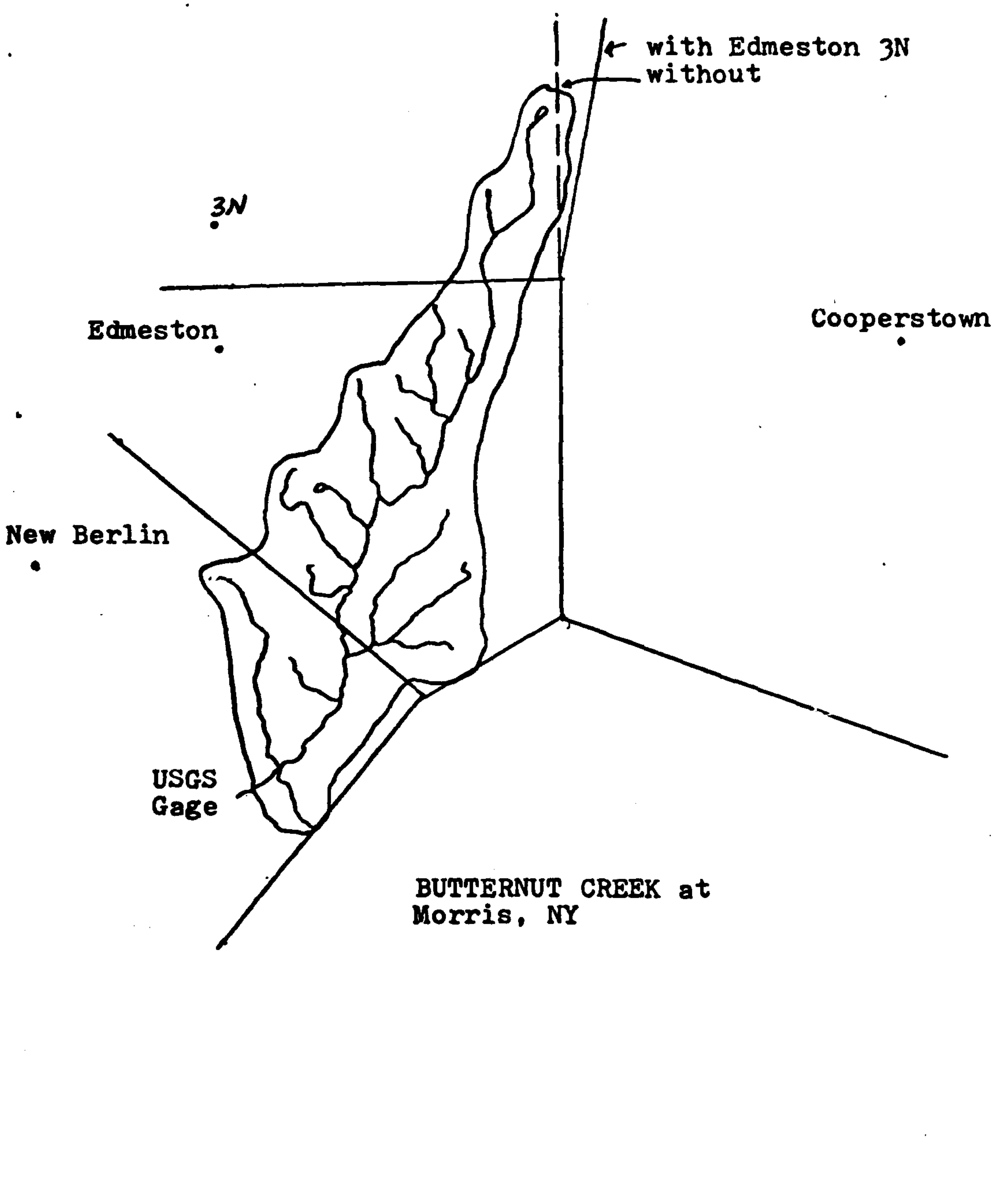
Specifically, the conclusions of this thesis are:

1. HEC-1 may be applied successfully in the study area.
2. Sensitivity of the parameters TC, R, STRTL, and CNSTL in HEC-1 are established.
3. The HEC-1 optimization search technique should be improved to give a global solution.
4. The relationship to determine the term STRTL needs to be improved.
5. Regional values of the term CNSTL are now established.
6. The initial and constant loss rate method is not the best method but it works fairly well.
7. The results should be applied seasonally.
8. Good correlation between the parameters TC and R with basin characteristics were obtained. The recommended equations are the first in each group in Figure 5.
9. A very good comparison with a 1970 study was obtained for the terms TC and R.

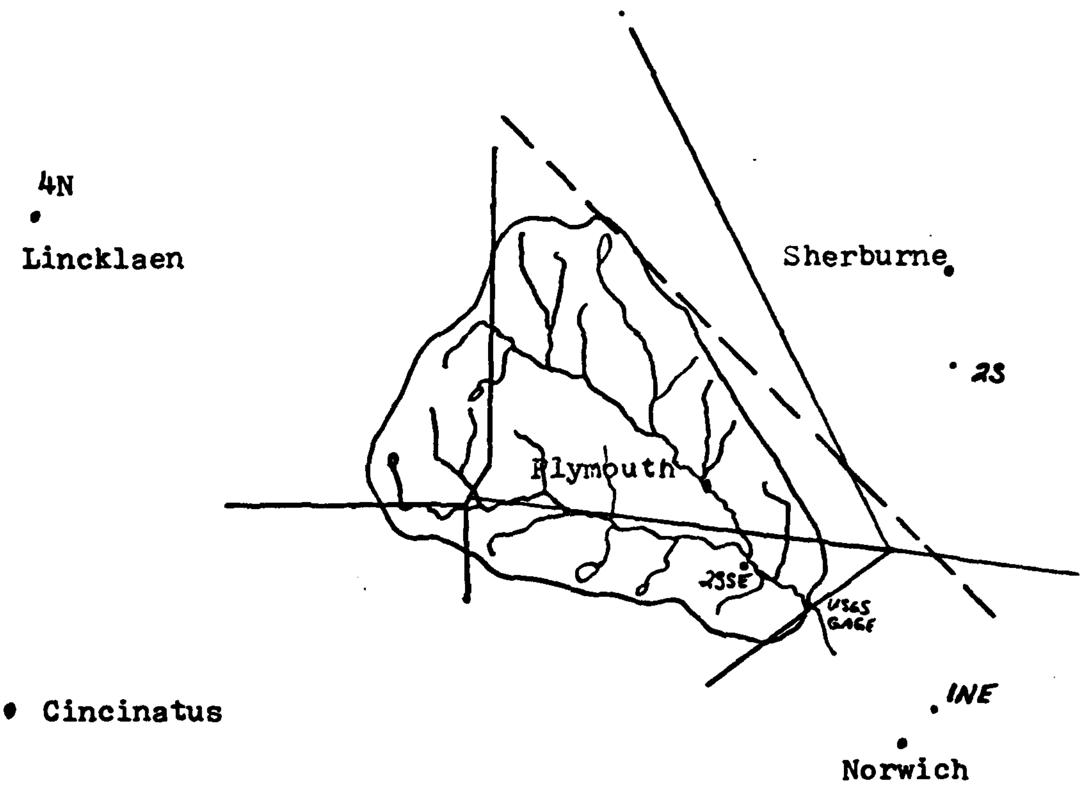
Appendix A Watershed Rain Gage Locations and Thiessen Polygons.

Recording Stations: Edmeston
Edmeston 3N

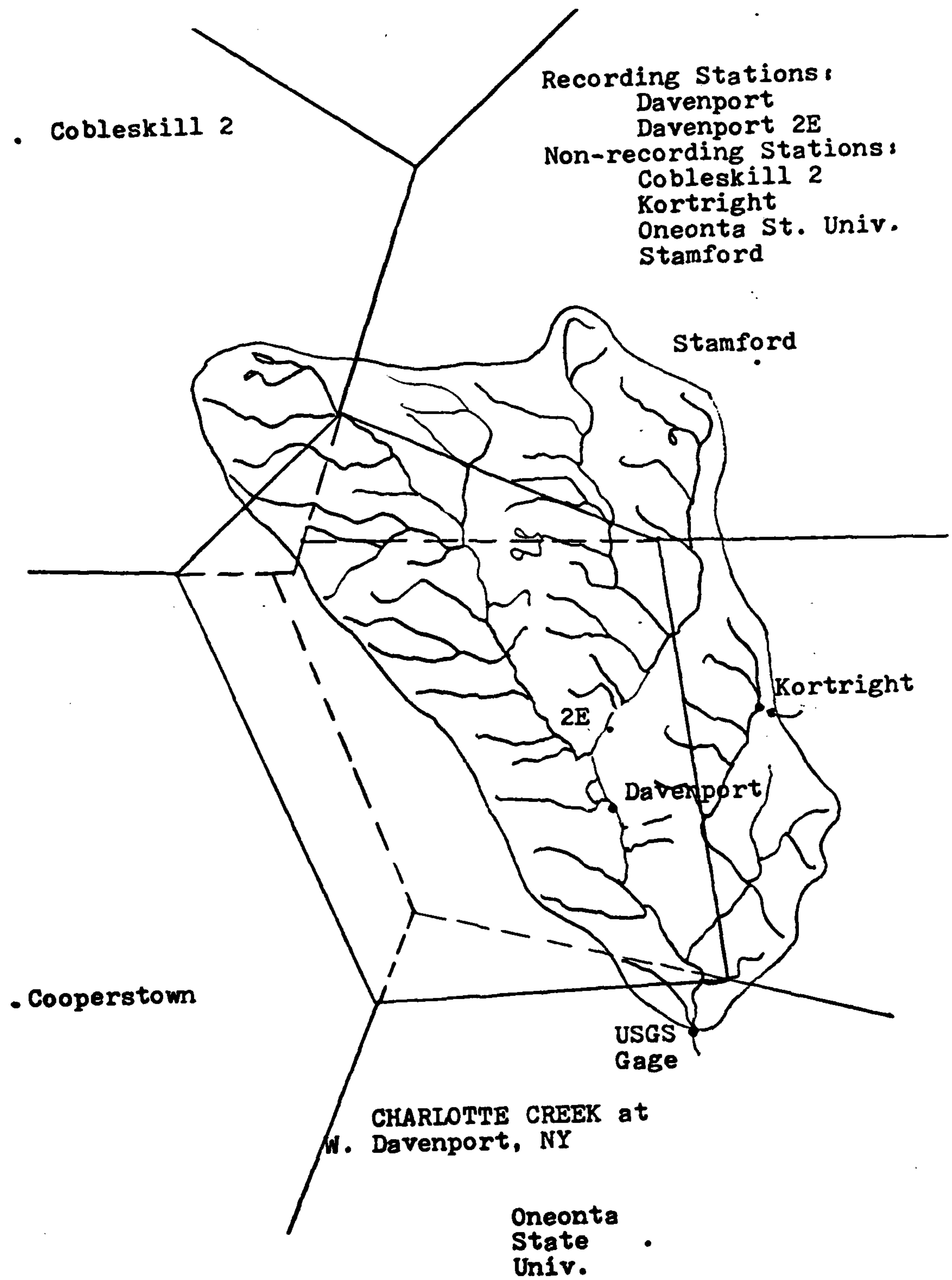
Non-recording Stations: Cooperstown
New Berlin



Recording Stations: Plymouth
Plymouth 2SSE
Non-recording Stations: Cincinatus
Lincklaen
Norwich
Norwich 1NE
Sherburne

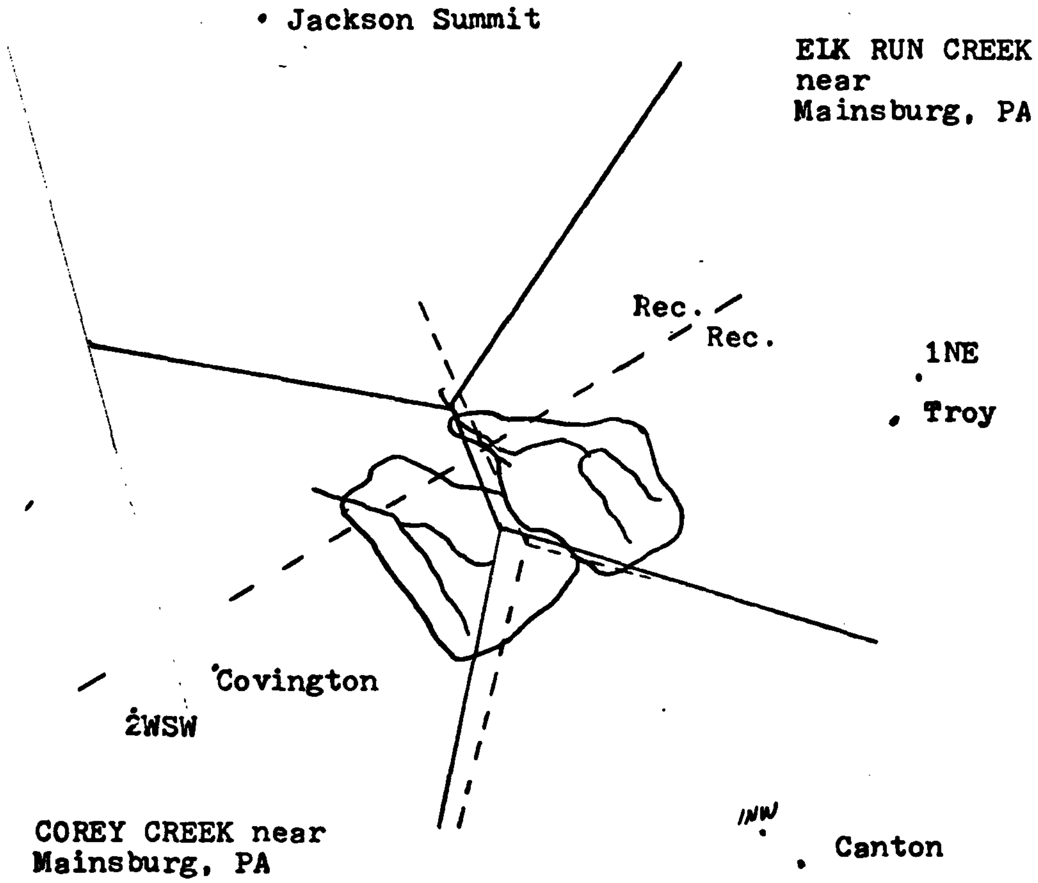



CANASAWACTA CREEK near
Plymouth, NY


Recording Stations:
Davenport
Davenport 2E
Non-recording Stations:
Cobleskill 2
Kortright
Oneonta St. Univ.
Stamford
Cobleskill 2
Stamford
Kortright
2E
Davenport
Cooperstown
USGS
Gage
CHARLOTTE CREEK at
W. Davenport, NY
Oneonta
State
Univ.

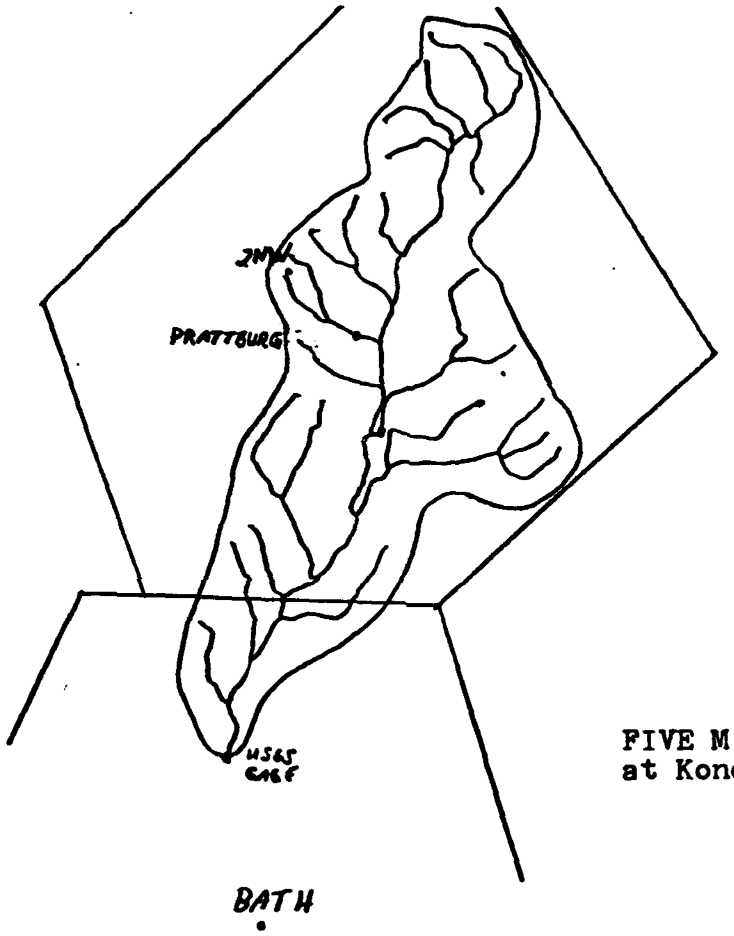
Recording Stations: Canton
Jackson Summit

Non-recording Stations: Canton
Covington
Troy



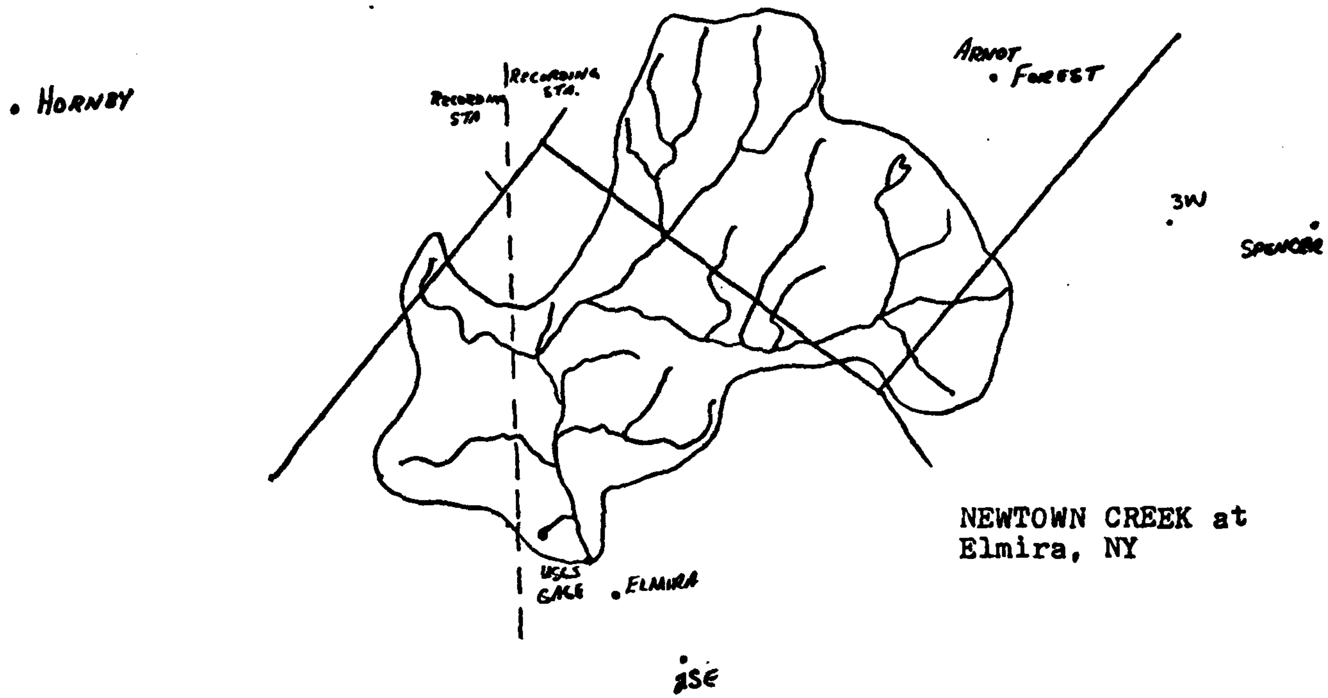
Recording Stations: None

Non-recording Stations: Bath
Prattburg




FIVE MILE CREEK
at Konona, NY

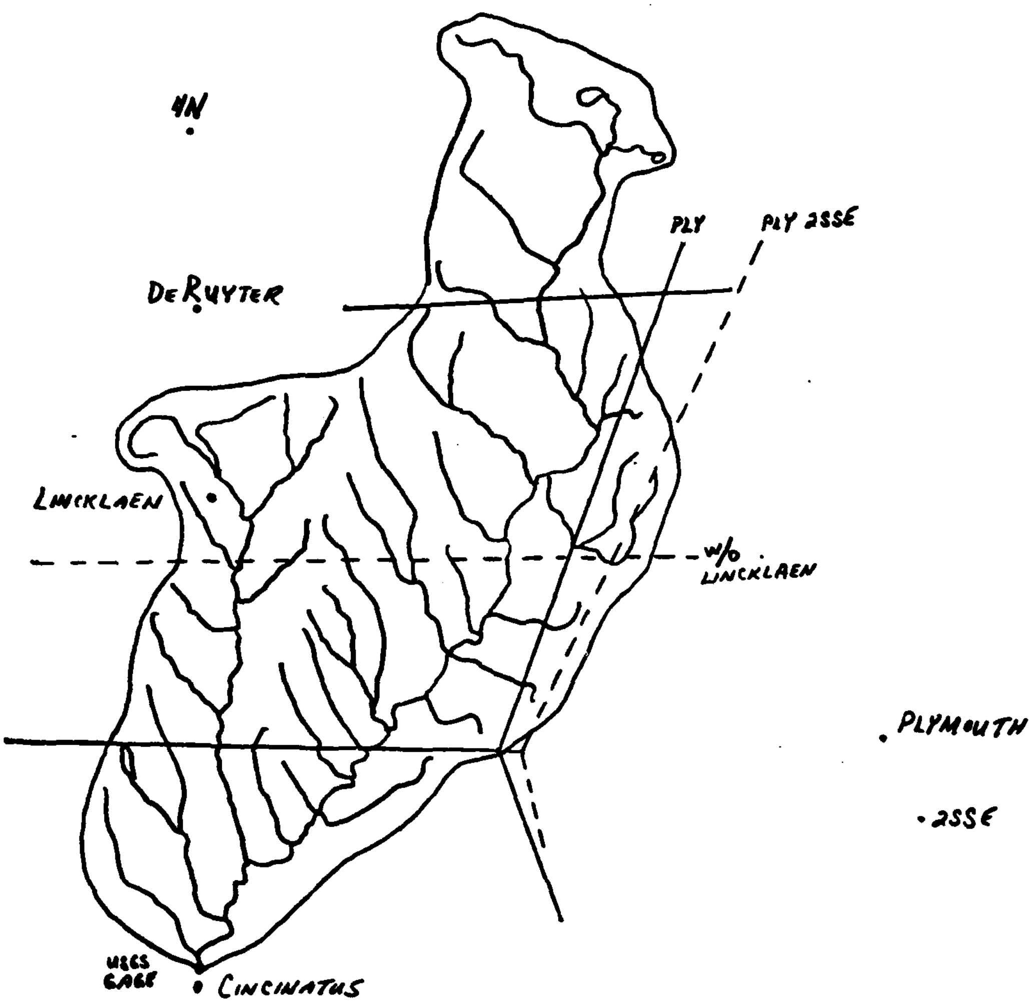
Recording Stations: Arnot Forest
Hornby
Non-recording Stations: Elmira
Spencer




NEWTOWN CREEK at
Elmira, NY

Recording Stations: Plymouth
Plymouth 2SSE

Non-recording Sta.s: Cincinatus
DeRuyter
Lincklaen

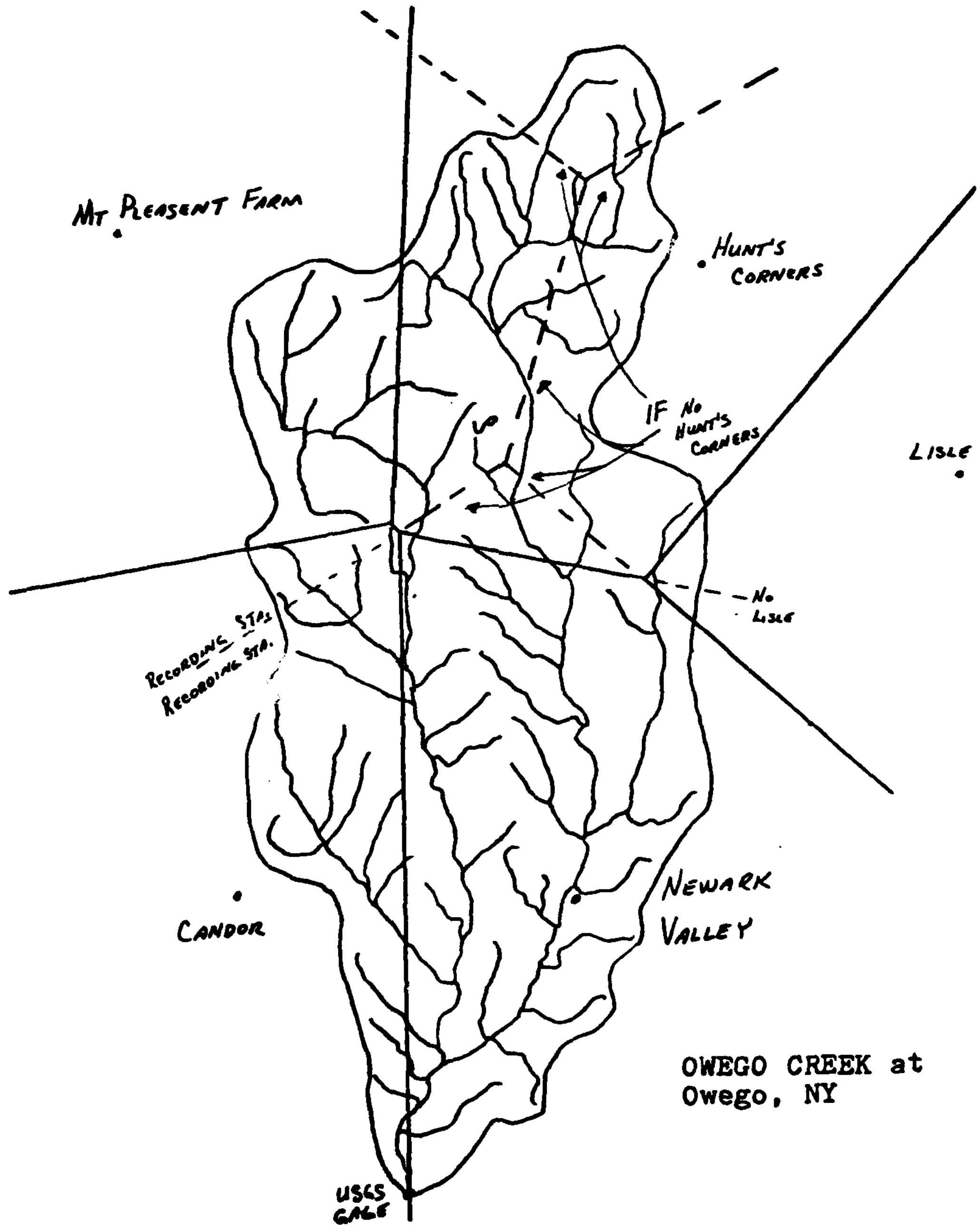



OTSELIC RIVER at
Cincinatus, NY

• Cortland

Recording Stations:
- Hunt's Corners
- Mt. Pleasent Farm
- Newark Valley

Non-recording Stations:
- Candor
- Cortland
- Lisle




OWEGO CREEK at
Owego, NY

## Appendix B

## Input Card Deck Description

A brief line-by-line explanation of a typical card deck used in this study follows:

ID -- (Identification card) Serves to identify job by providing an opportunity to make comments or to describe an operation to be performed.

IT -- (Identify Time periods card) Serves to establish hydrograph time axis (60 minutes), start date of storm hydrograph (24 September 1977), start time of storm hydrograph (1300 hours), and number of hydrograph ordinates which must match the total number of flowrate entries on the QO cards.

IO -- (Identify Output formats) Serves to request supression or printing of selected output, calculations, or plots.

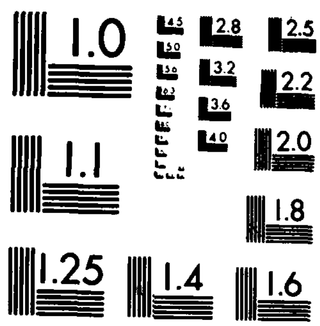
OU -- (Optimization limits for Unit hydrographs) The first number tells the program at which flood hydrograph ordinates optimization must be started. The second establishes the optimization ending ordinate.

PG -- (Precipitation Gage) Serves to identify rainfall gages. If a number follows the gage name, the gage is non-recording and the number is the total storm rainfall in inches. If no amount of rainfall is given, then the gage is a recording gage and must be followed by a PI card.

AD-A129 964 WATERSHED MODELLING IN THE CHEMUNG AND UPPER SUSQUEHANNA RIVER BASINS USI..(U) ARMY MILITARY PERSONNEL CENTER ALEXANDRIA VA J C STYRON 20 MAY 83

2/4

UNCLASSIFIED F/G 8/8 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0

PI -- (Precipitation, Incremental) Serves to follow a recording rain gage PG card to describe the temporal rainfall distribution of the recording gage. The values are spaced at the time interval established on the IT card. The first value must represent the amount of rain falling in the first time period indicated on the IT card. The start of the rain must coincide with the start of the flood hydrograph flowrate on the QO cards.

KK -- (Kontrol Kard) Serves to identify the name of the stream gaging station at the basin outlet and to separate the precipitation data cards from the outflow data.

QO -- (Discharge (Q) Ordinate) Serves to input the observed hydrograph ordinates. The first flow value must match the first PI card entry as well as the IT card, i.e. all occur at the same instant.

PT -- (Precipitation Gage Total) Serves to identify those precipitation gages (either recording or nonrecording) which cover some fraction of the basin and contribute to the basin runoff.

PW -- (Precipitation Gage Weightings) Serves to provide the fraction of the basin covered by the gage above it.

PR -- (Precipitation Recording) Serves to identify the recording stations which are used in deriving the temporal rainfall distribution pattern.

PW -- Same as the PW card above except it represents the

fraction of the basin covered only by recording stations.

BA -- (Basin Area) The first value is the drainage area while the second is the mean annual rainfall for the basin, if known.

BF -- (Base Flow) The values of STRTQ, QRCSN, and RTIOR respectively.

UC -- (Unit Hydrograph, Clark Method) The two parameters are the time of concentration (TC) and storage (R), respectively. If the numbers are positive, they remain constant throughout the calculations. If negative, the optimization routine begins with these values and then adjusts their values after removing the negative sign. If one or both are -1, then the optimization routine supplies an initial default value and then optimizes. In this model both parameters must be either positive or negative because of their interrelationship.

LU -- (Loss Rate, Initial and Uniform) The two parameters are the initial loss (STRTL) and the constant loss rate (CNSTL), respectively. The same definitions for positive and negative values apply as above, except that both do not have to be positive or negative at the same time.

ZZ -- (End of Data) HEC-1 begins calculations after all data is read into its scratch files.

```
                                            HEC-1 INPUT                                                PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        BUTTERNUT CREEK 10-18-75
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)

  3           IT      60 17OCT75    1300     114
  4           IU       1       2
  5           OU      10      65
  6           PG   EDMES
  7           PI     .00     .00     .00     .00     .00     .01     .10     .10     .05     .10
  8           PI     .20     .10     .19     .11     .16     .12     .07     .05     .03     .01
  9           PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 10           PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .03
 11           PI     .07     .05     .20     .17     .10     .02     .01     .04     .09     .02
 12           PI     .05     .07     .00     .00     .00     .00     .00     .00     .00     .00

 13           KK  MORRIS
 14           QO      93      93      92      92      91      91      91      92      93      97
 15           QO     101     113     136     172     247     345     608    1201    1700    2050
 16           QO    2489    2698    2914    3022    2974    2786    2588    2368    2130    1920
 17           QO    1727    1520    1307    1053     883     775     712     667     632     600
 18           QO     576     564     564     596     685     865    1113    1376    1601    1862
 19           QO    1740    2090    2070    2020    1960    1940    1930    1920    1910    1890
 20           QO    1817    1628    1469    1341    1225    1129    1016     928     835     780
 21           QO     740     708     680     658     636     616     596     580     568     552
 22           QO     540     528     513     503     489     481     467     457     447     438
 23           QO     429     420     414     408     396     390     383     378     373     368
 24           QO     360     355     350     345     340     336     332     328     324     322
 25           QO     318     314     312     310       0       0       0       0       0       0
 26           PT   EDMES
 27           PW    1.00      0.      0.      0.      0.
 28           PR   EDMES
 29           PW    1.00      0.      0.      0.      0.
 30           BA    59.7      0.
 31           BF     93.    590.  1.0191
 32           UC  -12.15     -8.
 33           LU     -0.     -0.
 34           ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 10 THROUGH 65)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.320 | | 26.54 | | | |
| COMPUTED HYDROGRAPH | 82015. | 2.129 | 1465. | 37.31 | 10.77 | 2820. | 23.00 |
| OBSERVED HYDROGRAPH | 79287. | 2.058 | 1416. | 39.40 | 12.86 | 3022. | 23.00 |
| DIFFERENCE | 2728. | 0.071 | 49. | -2.09 | -2.09 | -202. | 0.00 |
| PERCENT DIFFERENCE | 3.44 | | | | -16.23 | -6.67 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 291. | AVERAGE ABSOLUTE ERROR | 222. |
| OBJECTIVE FUNCTION | 268. | AVERAGE PERCENT ABSOLUTE ERROR | 40.58 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 114)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.320 | | 26.54 | | | |
| COMPUTED HYDROGRAPH | 104896. | 2.723 | 920. | 47.17 | 20.63 | 2820. | 23.00 |
| OBSERVED HYDROGRAPH | 104605. | 2.715 | 918. | 49.84 | 23.30 | 3022. | 23.00 |
| DIFFERENCE | 291. | 0.008 | 3. | -2.67 | -2.67 | -202. | 0.00 |
| PERCENT DIFFERENCE | 0.28 | | | | -11.47 | -6.67 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 208. | AVERAGE ABSOLUTE ERROR | 130. |
| OBJECTIVE FUNCTION | 236. | AVERAGE PERCENT ABSOLUTE ERROR | 26.04 |

UNIT HYDROGRAPH
58 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 64. | 240. | 487. | 772. | 1082. | 1406. | 1721. | 1984. | 2179. | 2295. |
| 2341. | 2295. | 2135. | 1925. | 1735. | 1564. | 1410. | 1271. | 1146. | 1033. |
| 931. | 839. | 756. | 682. | 615. | 554. | 499. | 450. | 406. | 366. |
| 330. | 297. | 268. | 242. | 218. | 196. | 177. | 159. | 144. | 130. |
| 117. | 105. | 95. | 86. | 77. | 70. | 63. | 57. | 51. | 46. |
| 41. | 37. | 34. | 30. | 27. | 25. | 22. | 20. | | |

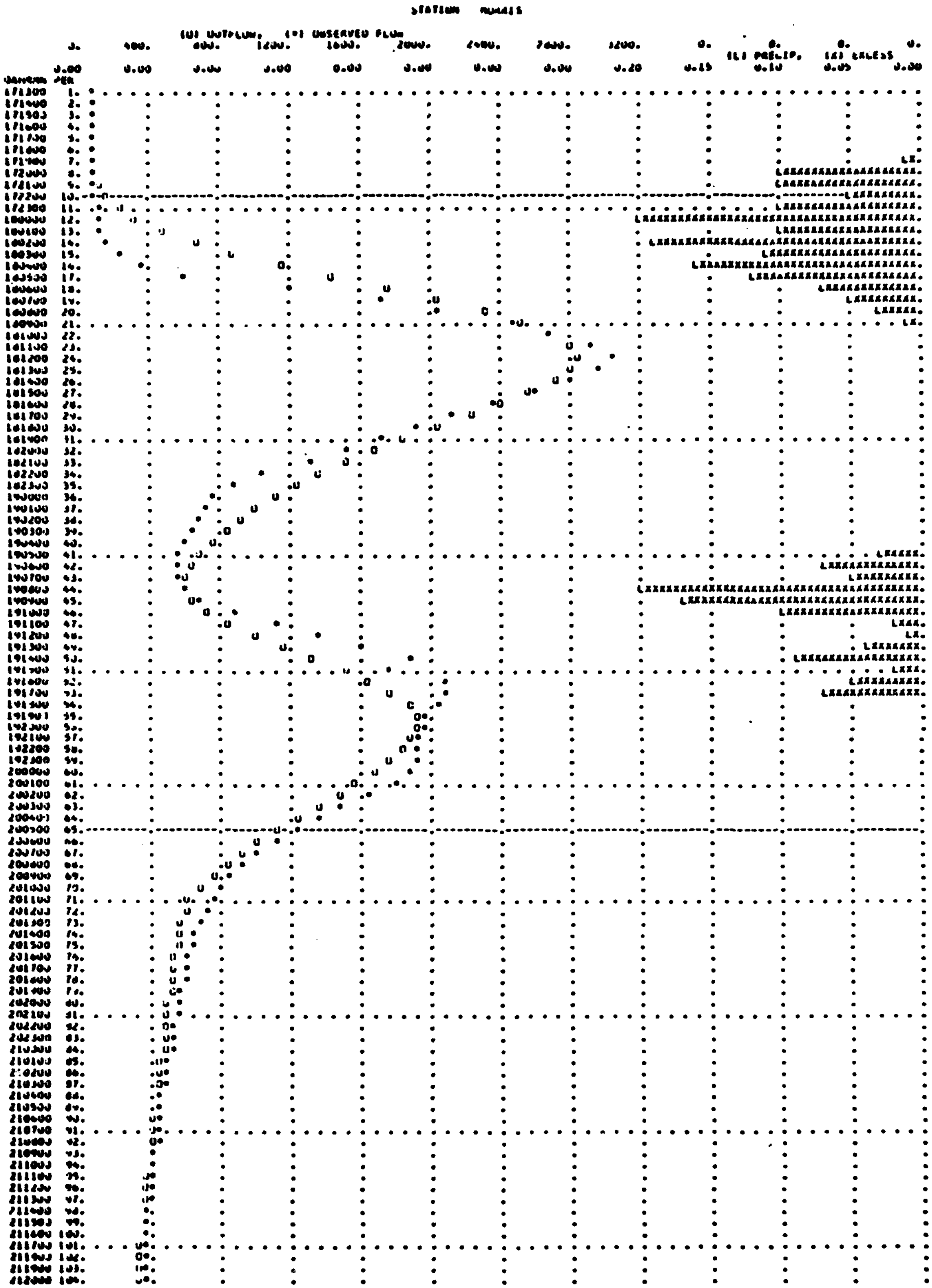
HYDROGRAPH AT STATION MORRIS

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 OCT 1300 | 1 | 0.00 | 0.00 | 0.00 | 93. | 93. | 19 OCT 2200 | 58 | 0.00 | 0.00 | 0.00 | 1825. | 1920. |
| 17 OCT 1400 | 2 | 0.00 | 0.00 | 0.00 | 91. | 93. | 19 OCT 2300 | 59 | 0.00 | 0.00 | 0.00 | 1753. | 1910. |
| 17 OCT 1500 | 3 | 0.00 | 0.00 | 0.00 | 90. | 92. | 20 OCT 0000 | 60 | 0.00 | 0.00 | 0.00 | 1671. | 1890. |
| 17 OCT 1600 | 4 | 0.00 | 0.00 | 0.00 | 88. | 92. | 20 OCT 0100 | 61 | 0.00 | 0.00 | 0.00 | 1577. | 1817. |
| 17 OCT 1700 | 5 | 0.00 | 0.00 | 0.00 | 86. | 91. | 20 OCT 0200 | 62 | 0.00 | 0.00 | 0.00 | 1471. | 1628. |
| 17 OCT 1800 | 6 | 0.00 | 0.00 | 0.00 | 85. | 91. | 20 OCT 0300 | 63 | 0.00 | 0.00 | 0.00 | 1358. | 1469. |
| 17 OCT 1900 | 7 | 0.01 | 0.00 | 0.01 | 84. | 91. | 20 OCT 0400 | 64 | 0.00 | 0.00 | 0.00 | 1243. | 1341. |
| 17 OCT 2000 | 8 | 0.10 | 0.00 | 0.10 | 90. | 92. | 20 OCT 0500 | 65 | 0.00 | 0.00 | 0.00 | 1127. | 1225. |
| 17 OCT 2100 | 9 | 0.10 | 0.00 | 0.10 | 115. | 93. | 20 OCT 0600 | 66 | 0.00 | 0.00 | 0.00 | 1016. | 1129. |
| 17 OCT 2200 | 10 | 0.05 | 0.00 | 0.05 | 162. | 97. | 20 OCT 0700 | 67 | 0.00 | 0.00 | 0.00 | 916. | 1016. |
| 17 OCT 2300 | 11 | 0.10 | 0.00 | 0.10 | 232. | 101. | 20 OCT 0800 | 68 | 0.00 | 0.00 | 0.00 | 827. | 928. |
| 18 OCT 0000 | 12 | 0.20 | 0.00 | 0.20 | 336. | 113. | 20 OCT 0900 | 69 | 0.00 | 0.00 | 0.00 | 746. | 835. |
| 18 OCT 0100 | 13 | 0.10 | 0.00 | 0.10 | 482. | 136. | 20 OCT 1000 | 70 | 0.00 | 0.00 | 0.00 | 671. | 780. |
| 18 OCT 0200 | 14 | 0.19 | 0.00 | 0.19 | 670. | 172. | 20 OCT 1100 | 71 | 0.00 | 0.00 | 0.00 | 605. | 740. |
| 18 OCT 0300 | 15 | 0.11 | 0.00 | 0.11 | 898. | 247. | 20 OCT 1200 | 72 | 0.00 | 0.00 | 0.00 | 582. | 708. |
| 18 OCT 0400 | 16 | 0.16 | 0.00 | 0.16 | 1158. | 345. | 20 OCT 1300 | 73 | 0.00 | 0.00 | 0.00 | 571. | 680. |
| 18 OCT 0500 | 17 | 0.12 | 0.00 | 0.12 | 1446. | 608. | 20 OCT 1400 | 74 | 0.00 | 0.00 | 0.00 | 560. | 658. |
| 18 OCT 0600 | 18 | 0.07 | 0.00 | 0.07 | 1748. | 1201. | 20 OCT 1500 | 75 | 0.00 | 0.00 | 0.00 | 550. | 636. |
| 18 OCT 0700 | 19 | 0.05 | 0.00 | 0.05 | 2040. | 1700. | 20 OCT 1600 | 76 | 0.00 | 0.00 | 0.00 | 539. | 616. |
| 18 OCT 0800 | 20 | 0.03 | 0.00 | 0.03 | 2303. | 2050. | 20 OCT 1700 | 77 | 0.00 | 0.00 | 0.00 | 529. | 596. |
| 18 OCT 0900 | 21 | 0.01 | 0.00 | 0.01 | 2523. | 2489. | 20 OCT 1800 | 78 | 0.00 | 0.00 | 0.00 | 519. | 580. |
| 18 OCT 1000 | 22 | 0.00 | 0.00 | 0.00 | 2685. | 2698. | 20 OCT 1900 | 79 | 0.00 | 0.00 | 0.00 | 510. | 568. |
| 18 OCT 1100 | 23 | 0.00 | 0.00 | 0.00 | 2788. | 2914. | 20 OCT 2000 | 80 | 0.00 | 0.00 | 0.00 | 500. | 552. |
| 18 OCT 1200 | 24 | 0.00 | 0.00 | 0.00 | 2820. | 3022. | 20 OCT 2100 | 81 | 0.00 | 0.00 | 0.00 | 491. | 540. |
| 18 OCT 1300 | 25 | 0.00 | 0.00 | 0.00 | 2789. | 2974. | 20 OCT 2200 | 82 | 0.00 | 0.00 | 0.00 | 481. | 528. |
| 18 OCT 1400 | 26 | 0.00 | 0.00 | 0.00 | 2702. | 2786. | 20 OCT 2300 | 83 | 0.00 | 0.00 | 0.00 | 472. | 513. |
| 18 OCT 1500 | 27 | 0.00 | 0.00 | 0.00 | 2570. | 2584. | 21 OCT 0000 | 84 | 0.00 | 0.00 | 0.00 | 464. | 503. |
| 18 OCT 1600 | 28 | 0.00 | 0.00 | 0.00 | 2406. | 2368. | 21 OCT 0100 | 85 | 0.00 | 0.00 | 0.00 | 455. | 489. |
| 18 OCT 1700 | 29 | 0.00 | 0.00 | 0.00 | 2221. | 2130. | 21 OCT 0200 | 86 | 0.00 | 0.00 | 0.00 | 446. | 481. |
| 18 OCT 1800 | 30 | 0.00 | 0.00 | 0.00 | 2332. | 1920. | 21 OCT 0300 | 87 | 0.00 | 0.00 | 0.00 | 438. | 467. |
| 18 OCT 1900 | 31 | 0.00 | 0.00 | 0.00 | 1848. | 1727. | 21 OCT 0400 | 88 | 0.00 | 0.00 | 0.00 | 430. | 457. |
| 18 OCT 2000 | 32 | 0.00 | 0.00 | 0.00 | 1674. | 1520. | 21 OCT 0500 | 89 | 0.00 | 0.00 | 0.00 | 422. | 447. |
| 18 OCT 2100 | 33 | 0.00 | 0.00 | 0.00 | 1514. | 1307. | 21 OCT 0600 | 90 | 0.00 | 0.00 | 0.00 | 414. | 438. |
| 18 OCT 2200 | 34 | 0.00 | 0.00 | 0.00 | 1366. | 1053. | 21 OCT 0700 | 91 | 0.00 | 0.00 | 0.00 | 406. | 429. |
| 18 OCT 2300 | 35 | 0.00 | 0.00 | 0.00 | 1237. | 883. | 21 OCT 0800 | 92 | 0.00 | 0.00 | 0.00 | 398. | 420. |
| 19 OCT 0000 | 36 | 0.00 | 0.00 | 0.00 | 1119. | 775. | 21 OCT 0900 | 93 | 0.00 | 0.00 | 0.00 | 391. | 414. |
| 19 OCT 0100 | 37 | 0.00 | 0.00 | 0.00 | 1013. | 712. | 21 OCT 1000 | 94 | 0.00 | 0.00 | 0.00 | 384. | 408. |
| 19 OCT 0200 | 38 | 0.00 | 0.00 | 0.00 | 917. | 667. | 21 OCT 1100 | 95 | 0.00 | 0.00 | 0.00 | 376. | 396. |
| 19 OCT 0300 | 39 | 0.00 | 0.00 | 0.00 | 830. | 632. | 21 OCT 1200 | 96 | 0.00 | 0.00 | 0.00 | 369. | 390. |
| 19 OCT 0400 | 40 | 0.00 | 0.00 | 0.00 | 752. | 600. | 21 OCT 1300 | 97 | 0.00 | 0.00 | 0.00 | 362. | 383. |
| 19 OCT 0500 | 41 | 0.03 | 0.00 | 0.03 | 663. | 576. | 21 OCT 1400 | 98 | 0.00 | 0.00 | 0.00 | 356. | 378. |
| 19 OCT 0600 | 42 | 0.07 | 0.00 | 0.07 | 629. | 564. | 21 OCT 1500 | 99 | 0.00 | 0.00 | 0.00 | 349. | 373. |
| 19 OCT 0700 | 43 | 0.05 | 0.00 | 0.05 | 595. | 564. | 21 OCT 1600 | 100 | 0.00 | 0.00 | 0.00 | 342. | 368. |
| 19 OCT 0800 | 44 | 0.20 | 0.00 | 0.20 | 590. | 596. | 21 OCT 1700 | 101 | 0.00 | 0.00 | 0.00 | 336. | 360. |
| 19 OCT 0900 | 45 | 0.17 | 0.00 | 0.17 | 631. | 685. | 21 OCT 1800 | 102 | 0.00 | 0.00 | 0.00 | 330. | 355. |
| 19 OCT 1000 | 46 | 0.10 | 0.00 | 0.10 | 720. | 865. | 21 OCT 1900 | 103 | 0.00 | 0.00 | 0.00 | 324. | 350. |
| 19 OCT 1100 | 47 | 0.02 | 0.00 | 0.02 | 848. | 1113. | 21 OCT 2000 | 104 | 0.00 | 0.00 | 0.00 | 317. | 345. |
| 19 OCT 1200 | 48 | 0.01 | 0.00 | 0.01 | 999. | 1376. | 21 OCT 2100 | 105 | 0.00 | 0.00 | 0.00 | 312. | 340. |
| 19 OCT 1300 | 49 | 0.04 | 0.00 | 0.04 | 1163. | 1601. | 21 OCT 2200 | 106 | 0.00 | 0.00 | 0.00 | 306. | 336. |
| 19 OCT 1400 | 50 | 0.09 | 0.00 | 0.09 | 1335. | 1462. | 21 OCT 2300 | 107 | 0.00 | 0.00 | 0.00 | 300. | 332. |
| 19 OCT 1500 | 51 | 0.02 | 0.00 | 0.02 | 1503. | 1740. | 22 OCT 0000 | 108 | 0.00 | 0.00 | 0.00 | 294. | 328. |
| 19 OCT 1600 | 52 | 0.05 | 0.00 | 0.05 | 1653. | 2090. | 22 OCT 0100 | 109 | 0.00 | 0.00 | 0.00 | 289. | 325. |
| 19 OCT 1700 | 53 | 0.07 | 0.00 | 0.07 | 1775. | 2070. | 22 OCT 0200 | 110 | 0.00 | 0.00 | 0.00 | 283. | 322. |
| 19 OCT 1800 | 54 | 0.00 | 0.00 | 0.00 | 1864. | 2020. | 22 OCT 0300 | 111 | 0.00 | 0.00 | 0.00 | 278. | 318. |
| 19 OCT 1900 | 55 | 0.00 | 0.00 | 0.00 | 1916. | 1960. | 22 OCT 0400 | 112 | 0.00 | 0.00 | 0.00 | 273. | 314. |
| 19 OCT 2000 | 56 | 0.00 | 0.00 | 0.00 | 1921. | 1940. | 22 OCT 0500 | 113 | 0.00 | 0.00 | 0.00 | 268. | 312. |
| 19 OCT 2100 | 57 | 0.00 | 0.00 | 0.00 | 1885. | 1930. | 22 OCT 0600 | 114 | 0.00 | 0.00 | 0.00 | 263. | 310. |

TOTAL RAINFALL = 2.32, TOTAL LOSS = 0.00, TOTAL EXCESS = 2.32

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 113.00-HR |
|---|---|---|---|---|---|---|
| 2820. | 23.00 | (CFS) | 2721. | 1908. | 1289. | 927. |
| | | (INCHES) | 0.424 | 1.188 | 2.409 | 2.718 |
| | | (AC-FT) | 1349. | 3784. | 7671. | 8654. |

CUMULATIVE AREA = 59.70 SQ MI


STATION
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS

```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID        BUTTERNUT CREEK 10-09-76
  2         ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)

  3         IT      60 07OCT76    1700     105
  4         IO       1       2
  5         OU      35      60
  6         PG      NB    2.11
  7         PG      ED
  8         PI     .00     .00     .00     .00     .02     .03     .09     .06     .06     .15
  9         PI     .01     .03     .01     .01     .01     .00     .00     .00     .01     .01
 10         PI     .02     .01     .01     .00     .00     .00     .00     .05     .00     .06
 11         PI     .01     .02     .01     .04     .14     .13     .11     .14     .09     .17
 12         PI     .21     .17     .33     .32     .10     .05     .00     .00     .01     .02
 13         PG    ED3N
 14         PI     .00     .00     .00     .00     .00     .00      .2      .1      .1      .1
 15         PI      .1      .0      .1      .0      .0      .0      .0      .0      .0      .0
 16         PI      .0      .0      .1      .0      .0      .0      .0      .0      .0      .1
 17         PI      .0      .0      .0      .0      .1      .2      .1      .1      .2      .1
 18         PI      .2      .2      .4      .3      .1      .0      .1      .0      .0      .0

 19         KK  MORRIS
 20         QO      34      34      34      34      34      33      33      33      34      34
 21         QO      35      35      36      37      38      39      41      43      47      51
 22         QO      53      55      56      58      59      59      59      59      60      60
 23         QO      60      59      60      61      63      67      74      85     104     132
 24         QO     183     266     378     564     921    1538    1862    2324    2632    2866
 25         QO    3106    3242    3268    3154    2914    2632    2368    2140    1940    1727
 26         QO    1478    1177     915     725     654     600     564     528     494     471
 27         QO     447     429     414     399     385     373     362     353     343     334
 28         QO     328     322     314     308     302     294     290     286     280     276
 29         QO     272     266     262     258     255     251     247     246     242     238
 30         QO     235     231     229     226     224       0       0       0       0       0
 31         PT      NB      ED    ED3N
 32         PW     .30     .58     .12      .0      .0
 33         PR      ED    ED3N       0       0       0
 34         PW     .88     .12      .0      .0      .0
 35         UA    59.7      0.
 36         BF     34.    400.  1.0191
 37         UC  -12.53   -8.07
 38         LU    -.35    -.03
 39         ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 35 THROUGH 60)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.276 | | 41.94 | | | |
| COMPUTED HYDROGRAPH | 40550. | 1.053 | 1560. | 51.84 | 9.91 | 3008. | 52.00 |
| OBSERVED HYDROGRAPH | 40550. | 1.053 | 1560. | 52.25 | 10.31 | 3268. | 52.00 |
| DIFFERENCE | 0. | 0.000 | 0. | -0.40 | -0.40 | -260. | 0.00 |
| PERCENT DIFFERENCE | 0.00 | | | | -3.88 | -7.96 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 176. | AVERAGE ABSOLUTE ERROR | 137. |
| OBJECTIVE FUNCTION | 174. | AVERAGE PERCENT ABSOLUTE ERROR | 29.87 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 105)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.276 | | 41.94 | | | |
| COMPUTED HYDROGRAPH | 58674. | 1.523 | 559. | 58.64 | 16.70 | 3008. | 52.00 |
| OBSERVED HYDROGRAPH | 60239. | 1.564 | 574. | 58.84 | 16.90 | 3268. | 52.00 |
| DIFFERENCE | -1565. | -0.041 | -15. | -0.20 | -0.20 | -260. | 0.00 |
| PERCENT DIFFERENCE | -2.60 | | | | -1.19 | -7.96 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 92. | AVERAGE ABSOLUTE ERROR | 47. |
| OBJECTIVE FUNCTION | 146. | AVERAGE PERCENT ABSOLUTE ERROR | 15.28 |

UNIT HYDROGRAPH
41 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 79. | 289. | 576. | 897. | 1234. | 1577. | 1919. | 2231. | 2469. | 2620. |
| 2691. | 2686. | 2603. | 2411. | 2113. | 1800. | 1533. | 1305. | 1112. | 947. |
| 806. | 687. | 585. | 498. | 424. | 361. | 308. | 262. | 223. | 190. |
| 162. | 138. | 117. | 100. | 85. | 73. | 62. | 53. | 45. | 38. |
| 32. | | | | | | | | | |

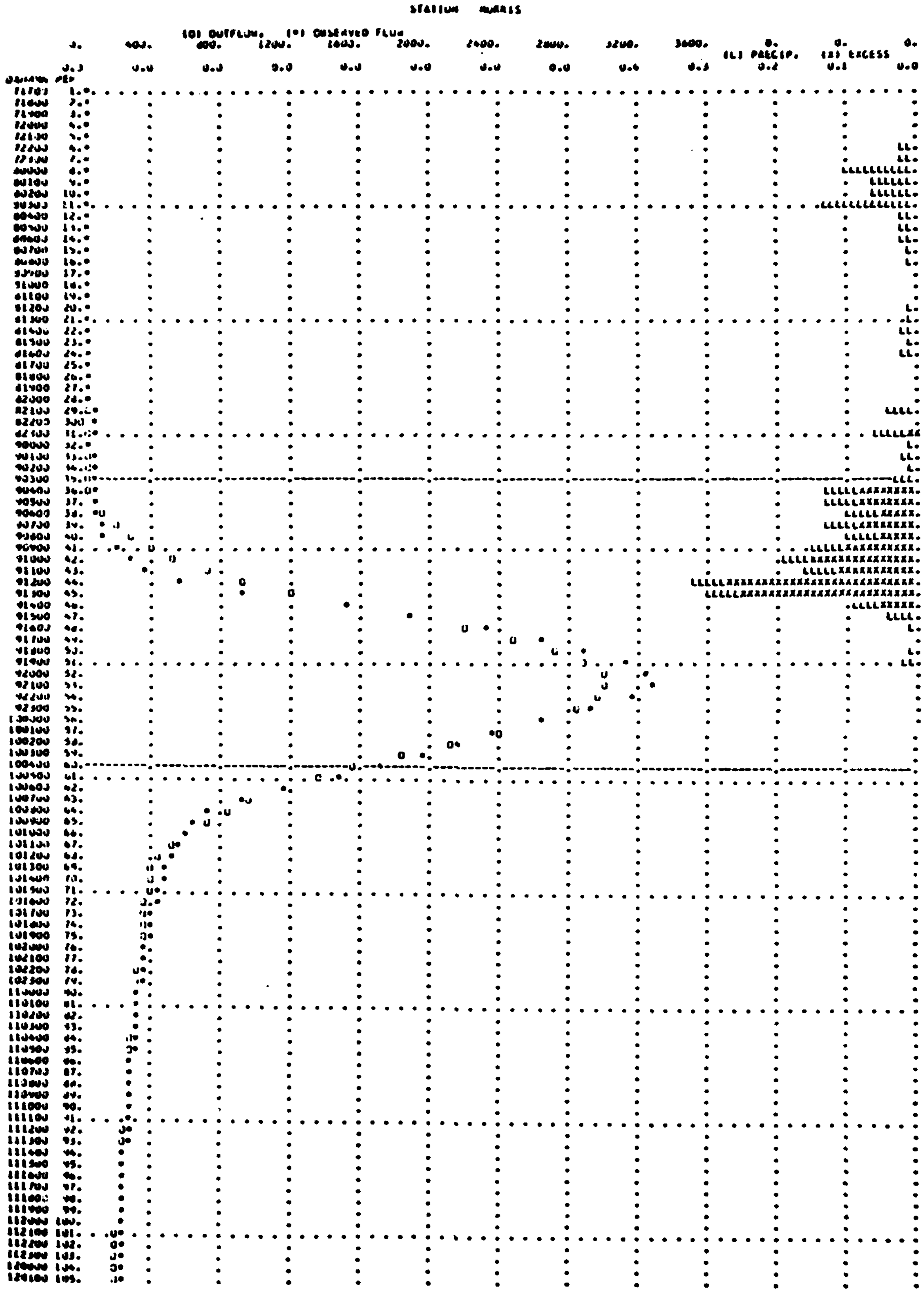
HYDROGRAPH AT STATION RUNKES

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 7 OCT 1700 | 1 | 0.00 | 0.00 | 0.00 | 34. | 34. |
| 7 OCT 1800 | 2 | 0.00 | 0.00 | 0.00 | 33. | 34. |
| 7 OCT 1900 | 3 | 0.00 | 0.00 | 0.00 | 33. | 34. |
| 7 OCT 2000 | 4 | 0.00 | 0.00 | 0.00 | 32. | 34. |
| 7 OCT 2100 | 5 | 0.00 | 0.00 | 0.00 | 32. | 34. |
| 7 OCT 2200 | 6 | 0.02 | 0.02 | 0.00 | 31. | 33. |
| 7 OCT 2300 | 7 | 0.02 | 0.02 | 0.00 | 30. | 33. |
| 8 OCT 0000 | 8 | 0.10 | 0.10 | 0.00 | 30. | 33. |
| 8 OCT 0100 | 9 | 0.06 | 0.06 | 0.00 | 29. | 34. |
| 8 OCT 0200 | 10 | 0.06 | 0.06 | 0.00 | 29. | 34. |
| 8 OCT 0300 | 11 | 0.13 | 0.13 | 0.00 | 28. | 35. |
| 8 OCT 0400 | 12 | 0.02 | 0.02 | 0.00 | 28. | 35. |
| 8 OCT 0500 | 13 | 0.02 | 0.02 | 0.00 | 27. | 36. |
| 8 OCT 0600 | 14 | 0.02 | 0.02 | 0.00 | 27. | 37. |
| 8 OCT 0700 | 15 | 0.01 | 0.01 | 0.00 | 26. | 38. |
| 8 OCT 0800 | 16 | 0.01 | 0.01 | 0.00 | 26. | 39. |
| 8 OCT 0900 | 17 | 0.00 | 0.00 | 0.00 | 25. | 41. |
| 8 OCT 1000 | 18 | 0.00 | 0.00 | 0.00 | 25. | 43. |
| 8 OCT 1100 | 19 | 0.00 | 0.00 | 0.00 | 24. | 47. |
| 8 OCT 1200 | 20 | 0.01 | 0.01 | 0.00 | 24. | 51. |
| 8 OCT 1300 | 21 | 0.01 | 0.01 | 0.00 | 23. | 53. |
| 8 OCT 1400 | 22 | 0.02 | 0.02 | 0.00 | 23. | 55. |
| 8 OCT 1500 | 23 | 0.01 | 0.01 | 0.00 | 22. | 56. |
| 8 OCT 1600 | 24 | 0.02 | 0.02 | 0.00 | 22. | 58. |
| 8 OCT 1700 | 25 | 0.00 | 0.00 | 0.00 | 22. | 59. |
| 8 OCT 1800 | 26 | 0.00 | 0.00 | 0.00 | 21. | 59. |
| 8 OCT 1900 | 27 | 0.00 | 0.00 | 0.00 | 21. | 59. |
| 8 OCT 2000 | 28 | 0.00 | 0.00 | 0.00 | 20. | 59. |
| 8 OCT 2100 | 29 | 0.04 | 0.04 | 0.00 | 20. | 60. |
| 8 OCT 2200 | 30 | 0.00 | 0.00 | 0.00 | 20. | 60. |
| 8 OCT 2300 | 31 | 0.06 | 0.05 | 0.01 | 20. | 60. |
| 9 OCT 0000 | 32 | 0.01 | 0.01 | 0.00 | 22. | 59. |
| 9 OCT 0100 | 33 | 0.02 | 0.02 | 0.00 | 26. | 60. |
| 9 OCT 0200 | 34 | 0.01 | 0.01 | 0.00 | 29. | 61. |
| 9 OCT 0300 | 35 | 0.03 | 0.03 | 0.00 | 33. | 63. |
| 9 OCT 0400 | 36 | 0.13 | 0.05 | 0.08 | 43. | 67. |
| 9 OCT 0500 | 37 | 0.13 | 0.05 | 0.08 | 70. | 74. |
| 9 OCT 0600 | 38 | 0.10 | 0.05 | 0.05 | 117. | 85. |
| 9 OCT 0700 | 39 | 0.13 | 0.05 | 0.08 | 185. | 104. |
| 9 OCT 0800 | 40 | 0.10 | 0.05 | 0.05 | 275. | 132. |
| 9 OCT 0900 | 41 | 0.15 | 0.05 | 0.10 | 367. | 183. |
| 9 OCT 1000 | 42 | 0.19 | 0.05 | 0.15 | 532. | 266. |
| 9 OCT 1100 | 43 | 0.16 | 0.05 | 0.11 | 712. | 378. |
| 9 OCT 1200 | 44 | 0.32 | 0.05 | 0.27 | 935. | 564. |
| 9 OCT 1300 | 45 | 0.30 | 0.05 | 0.25 | 1212. | 921. |
| 9 OCT 1400 | 46 | 0.09 | 0.05 | 0.05 | 1533. | 1538. |
| 9 OCT 1500 | 47 | 0.04 | 0.04 | 0.00 | 1867. | 1862. |
| 9 OCT 1600 | 48 | 0.01 | 0.01 | 0.00 | 2189. | 2324. |
| 9 OCT 1700 | 49 | 0.00 | 0.00 | 0.00 | 2476. | 2632. |
| 9 OCT 1800 | 50 | 0.01 | 0.01 | 0.00 | 2712. | 2866. |
| 9 OCT 1900 | 51 | 0.02 | 0.02 | 0.00 | 2885. | 3106. |
| 9 OCT 2000 | 52 | 0.00 | 0.00 | 0.00 | 2986. | 3242. |
| 9 OCT 2100 | 53 | 0.00 | 0.00 | 0.00 | 3008. | 3268. |
| 9 OCT 2200 | 54 | 0.00 | 0.00 | 0.00 | 2955. | 3154. |
| 9 OCT 2300 | 55 | 0.00 | 0.00 | 0.00 | 2832. | 2914. |
| 10 OCT 0000 | 56 | 0.00 | 0.00 | 0.00 | 2647. | 2632. |
| 10 OCT 0100 | 57 | 0.00 | 0.00 | 0.00 | 2411. | 2368. |
| 10 OCT 0200 | 58 | 0.00 | 0.00 | 0.00 | 2134. | 2140. |
| 10 OCT 0300 | 59 | 0.00 | 0.00 | 0.00 | 1842. | 1940. |
| 10 OCT 0400 | 60 | 0.00 | 0.00 | 0.00 | 1573. | 1727. |
| 10 OCT 0500 | 61 | 0.00 | 0.00 | 0.00 | 1341. | 1478. |
| 10 OCT 0600 | 62 | 0.00 | 0.00 | 0.00 | 1144. | 1177. |
| 10 OCT 0700 | 63 | 0.00 | 0.00 | 0.00 | 975. | 915. |
| 10 OCT 0800 | 64 | 0.00 | 0.00 | 0.00 | 832. | 725. |
| 10 OCT 0900 | 65 | 0.00 | 0.00 | 0.00 | 710. | 654. |
| 10 OCT 1000 | 66 | 0.00 | 0.00 | 0.00 | 606. | 600. |
| 10 OCT 1100 | 67 | 0.00 | 0.00 | 0.00 | 517. | 564. |
| 10 OCT 1200 | 68 | 0.00 | 0.00 | 0.00 | 442. | 528. |
| 10 OCT 1300 | 69 | 0.00 | 0.00 | 0.00 | 397. | 499. |
| 10 OCT 1400 | 70 | 0.00 | 0.00 | 0.00 | 390. | 471. |
| 10 OCT 1500 | 71 | 0.00 | 0.00 | 0.00 | 383. | 447. |
| 10 OCT 1600 | 72 | 0.00 | 0.00 | 0.00 | 375. | 429. |
| 10 OCT 1700 | 73 | 0.00 | 0.00 | 0.00 | 368. | 414. |
| 10 OCT 1800 | 74 | 0.00 | 0.00 | 0.00 | 362. | 399. |
| 10 OCT 1900 | 75 | 0.00 | 0.00 | 0.00 | 355. | 385. |
| 10 OCT 2000 | 76 | 0.00 | 0.00 | 0.00 | 348. | 373. |
| 10 OCT 2100 | 77 | 0.00 | 0.00 | 0.00 | 342. | 362. |
| 10 OCT 2200 | 78 | 0.00 | 0.00 | 0.00 | 335. | 353. |
| 10 OCT 2300 | 79 | 0.00 | 0.00 | 0.00 | 329. | 343. |
| 11 OCT 0000 | 80 | 0.00 | 0.00 | 0.00 | 323. | 334. |
| 11 OCT 0100 | 81 | 0.00 | 0.00 | 0.00 | 317. | 328. |
| 11 OCT 0200 | 82 | 0.00 | 0.00 | 0.00 | 311. | 322. |
| 11 OCT 0300 | 83 | 0.00 | 0.00 | 0.00 | 305. | 314. |
| 11 OCT 0400 | 84 | 0.00 | 0.00 | 0.00 | 299. | 308. |
| 11 OCT 0500 | 85 | 0.00 | 0.00 | 0.00 | 294. | 302. |
| 11 OCT 0600 | 86 | 0.00 | 0.00 | 0.00 | 288. | 294. |
| 11 OCT 0700 | 87 | 0.00 | 0.00 | 0.00 | 283. | 290. |
| 11 OCT 0800 | 88 | 0.00 | 0.00 | 0.00 | 277. | 286. |
| 11 OCT 0900 | 89 | 0.00 | 0.00 | 0.00 | 272. | 280. |
| 11 OCT 1000 | 90 | 0.00 | 0.00 | 0.00 | 267. | 276. |
| 11 OCT 1100 | 91 | 0.00 | 0.00 | 0.00 | 262. | 272. |
| 11 OCT 1200 | 92 | 0.00 | 0.00 | 0.00 | 257. | 266. |
| 11 OCT 1300 | 93 | 0.00 | 0.00 | 0.00 | 252. | 262. |
| 11 OCT 1400 | 94 | 0.00 | 0.00 | 0.00 | 248. | 258. |
| 11 OCT 1500 | 95 | 0.00 | 0.00 | 0.00 | 243. | 255. |
| 11 OCT 1600 | 96 | 0.00 | 0.00 | 0.00 | 238. | 251. |
| 11 OCT 1700 | 97 | 0.00 | 0.00 | 0.00 | 234. | 247. |
| 11 OCT 1800 | 98 | 0.00 | 0.00 | 0.00 | 230. | 244. |
| 11 OCT 1900 | 99 | 0.00 | 0.00 | 0.00 | 225. | 242. |
| 11 OCT 2000 | 100 | 0.00 | 0.00 | 0.00 | 221. | 238. |
| 11 OCT 2100 | 101 | 0.00 | 0.00 | 0.00 | 217. | 235. |
| 11 OCT 2200 | 102 | 0.00 | 0.00 | 0.00 | 213. | 231. |
| 11 OCT 2300 | 103 | 0.00 | 0.00 | 0.00 | 209. | 229. |
| 12 OCT 0000 | 104 | 0.00 | 0.00 | 0.00 | 205. | 226. |
| 12 OCT 0100 | 105 | 0.00 | 0.00 | 0.00 | 201. | 224. |

TOTAL RAINFALL = 2.57, TOTAL LOSS = 1.29, TOTAL EXCESS = 1.28

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 106.00-HR |
|---|---|---|---|---|---|---|
| 3268. | 52.00 | (CFS) | 2891. | 1853. | 802. | 563. |
| | | (INCHES) | 0.450 | 1.154 | 1.499 | 1.520 |
| | | (AC-FT) | 1433. | 3676. | 4771. | 4839. |

CUMULATIVE AREA = 59.70 SQ MI


STATION MORRIS
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS

```
LINE    ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1     ID        BUTTERNUT CREEK 10-21-76
  2     ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)

  3     IT      60 20OCT76    0100     101
  4     IO       1       2
  5     QU      15      45
  6     PG      NB    2.69
  7     PG      ED
  8     PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .01
  9     PI     .08     .02     .04     .03     .05     .07     .11     .18     .18     .08
 10     PI     .07     .09     .03     .29     .40     .21     .11     .10     .04     .00
 11     PG    ED3N
 12     PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 13     PI     .10     .10     .00     .00     .10     .10     .10     .10     .20     .10
 14     PI     .10     .10     .10     .20     .00     .00     .00     .00     .00     .00

 15     KK  MORRIS
 16     QO     148     148     148     146     146     145     145     145     143     145
 17     QO     146     148     153     158     166     177     190     208     237     284
 18     QO     355     475     636     808    1038    1367    1754    2080    2522    2950
 19     QO    3268    3502    3622    3692    3650    3515    3294    3106    2890    2698
 20     QO    2522    2313    2050    1745    1461    1233    1068     957     877     819
 21     QO     770     735     703     676     649     628     608     588     568     548
 22     QO     532     513     503     489     475     461     450     438     432     420
 23     QO     411     402     393     387     380     375     368     362     358     350
 24     QO     345     340     336     332     328     324     320     316     312     310
 25     QO     306     302     298     294     290     288     284     282     278     276
 26     QO     274       0       0       0       0       0       0       0       0       0
 27     PT      NB      ED    ED3N
 28     PW     .30     .58     .12      .0      .0
 29     PR      ED    ED3N       0       0       0
 30     PW     .88     .12      .0      .0      .0
 31     BA    59.7      0.
 32     BF    148.    340.  1.0191
 33     UC    -11.    -13.
 34     LU     -0.     -0.
 35     ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 15 THROUGH 45)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.245 | | 22.51 | | | |
| COMPUTED HYDROGRAPH | 63347. | 1.644 | 2043. | 33.72 | 11.21 | 3511. | 34.00 |
| OBSERVED HYDROGRAPH | 58575. | 1.520 | 1890. | 34.27 | 11.77 | 3692. | 33.00 |
| DIFFERENCE | 4772. | 0.124 | 154. | -0.56 | -0.56 | -181. | 1.00 |
| PERCENT DIFFERENCE | 8.15 | | | | -4.72 | -4.91 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 281. | AVERAGE ABSOLUTE ERROR | 229. |
| OBJECTIVE FUNCTION | 254. | AVERAGE PERCENT ABSOLUTE ERROR | 32.81 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 101)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.245 | | 22.51 | | | |
| COMPUTED HYDROGRAPH | 95982. | 2.491 | 950. | 42.39 | 19.88 | 3511. | 34.00 |
| OBSERVED HYDROGRAPH | 87000. | 2.258 | 861. | 43.60 | 21.09 | 3692. | 33.00 |
| DIFFERENCE | 8982. | 0.233 | 89. | -1.21 | -1.21 | -181. | 1.00 |
| PERCENT DIFFERENCE | 10.32 | | | | -5.74 | -4.91 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 238. | AVERAGE ABSOLUTE ERROR | 160. |
| OBJECTIVE FUNCTION | 275. | AVERAGE PERCENT ABSOLUTE ERROR | 29.92 |

UNIT HYDROGRAPH
81 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 51. | 193. | 396. | 634. | 898. | 1177. | 1436. | 1644. | 1796. | 1888. |
| 1901. | 1821. | 1696. | 1579. | 1471. | 1370. | 1276. | 1188. | 1107. | 1031. |
| 963. | 899. | 832. | 775. | 722. | 672. | 626. | 583. | 543. | 506. |
| 471. | 439. | 409. | 381. | 354. | 330. | 307. | 286. | 267. | 248. |
| 231. | 215. | 201. | 187. | 174. | 162. | 151. | 141. | 131. | 122. |
| 114. | 106. | 98. | 92. | 85. | 80. | 74. | 69. | 64. | 60. |
| 56. | 52. | 48. | 45. | 42. | 39. | 36. | 34. | 32. | 29. |
| 27. | 25. | 24. | 22. | 21. | 19. | 18. | 17. | 15. | 14. |
| 13. | | | | | | | | | |

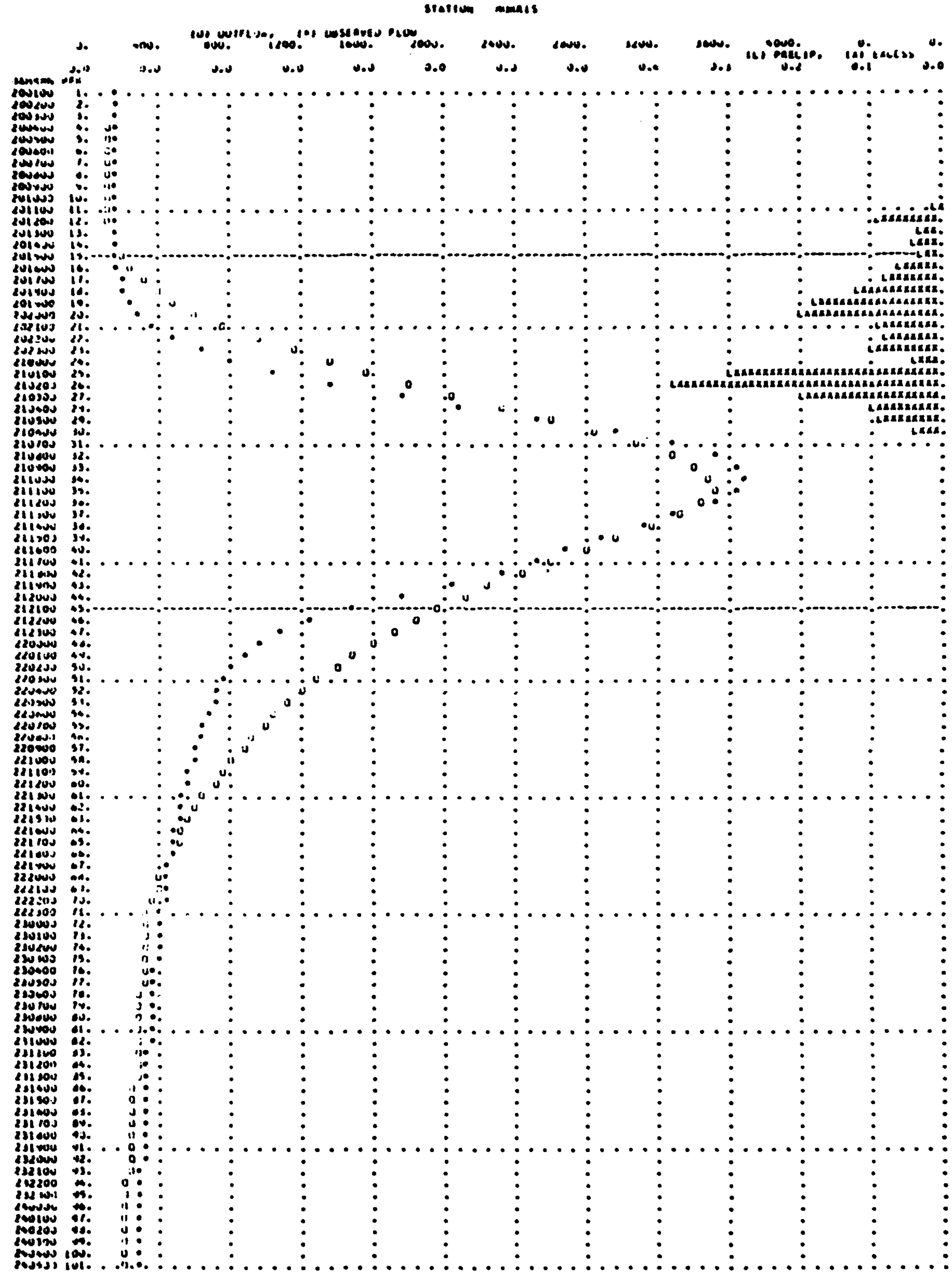
HYDROGRAPH AT STATION MORRIS

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 20 OCT 0100 | 1 | 0.00 | 0.00 | 0.00 | 148. | 146. |
| 20 OCT 0200 | 2 | 0.00 | 0.00 | 0.00 | 145. | 148. |
| 20 OCT 0300 | 3 | 0.00 | 0.00 | 0.00 | 143. | 146. |
| 20 OCT 0400 | 4 | 0.00 | 0.00 | 0.00 | 140. | 146. |
| 20 OCT 0500 | 5 | 0.00 | 0.00 | 0.00 | 137. | 146. |
| 20 OCT 0600 | 6 | 0.00 | 0.00 | 0.00 | 135. | 145. |
| 20 OCT 0700 | 7 | 0.00 | 0.00 | 0.00 | 132. | 145. |
| 20 OCT 0800 | 8 | 0.00 | 0.00 | 0.00 | 130. | 145. |
| 20 OCT 0900 | 9 | 0.00 | 0.00 | 0.00 | 127. | 143. |
| 20 OCT 1000 | 10 | 0.00 | 0.00 | 0.00 | 125. | 145. |
| 20 OCT 1100 | 11 | 0.01 | 0.00 | 0.01 | 123. | 146. |
| 20 OCT 1200 | 12 | 0.09 | 0.00 | 0.09 | 127. | 148. |
| 20 OCT 1300 | 13 | 0.03 | 0.00 | 0.03 | 140. | 153. |
| 20 OCT 1400 | 14 | 0.04 | 0.00 | 0.04 | 165. | 158. |
| 20 OCT 1500 | 15 | 0.03 | 0.00 | 0.03 | 199. | 166. |
| 20 OCT 1600 | 16 | 0.06 | 0.00 | 0.06 | 245. | 177. |
| 20 OCT 1700 | 17 | 0.08 | 0.00 | 0.08 | 306. | 190. |
| 20 OCT 1800 | 18 | 0.12 | 0.00 | 0.12 | 384. | 208. |
| 20 OCT 1900 | 19 | 0.18 | 0.00 | 0.18 | 484. | 237. |
| 20 OCT 2000 | 20 | 0.20 | 0.00 | 0.20 | 615. | 284. |
| 20 OCT 2100 | 21 | 0.09 | 0.00 | 0.09 | 776. | 355. |
| 20 OCT 2200 | 22 | 0.08 | 0.00 | 0.08 | 957. | 475. |
| 20 OCT 2300 | 23 | 0.10 | 0.00 | 0.10 | 1149. | 636. |
| 21 OCT 0000 | 24 | 0.04 | 0.00 | 0.04 | 1347. | 808. |
| 21 OCT 0100 | 25 | 0.30 | 0.00 | 0.30 | 1554. | 1038. |
| 21 OCT 0200 | 26 | 0.38 | 0.00 | 0.38 | 1744. | 1367. |
| 21 OCT 0300 | 27 | 0.20 | 0.00 | 0.20 | 2041. | 1754. |
| 21 OCT 0400 | 28 | 0.10 | 0.00 | 0.10 | 2312. | 2083. |
| 21 OCT 0500 | 29 | 0.09 | 0.00 | 0.09 | 2582. | 2522. |
| 21 OCT 0600 | 30 | 0.04 | 0.00 | 0.04 | 2838. | 2950. |
| 21 OCT 0700 | 31 | 0.00 | 0.00 | 0.00 | 3070. | 3268. |
| 21 OCT 0800 | 32 | 0.00 | 0.00 | 0.00 | 3263. | 3502. |
| 21 OCT 0900 | 33 | 0.00 | 0.00 | 0.00 | 3406. | 3622. |
| 21 OCT 1000 | 34 | 0.00 | 0.00 | 0.00 | 3491. | 3692. |
| 21 OCT 1100 | 35 | 0.00 | 0.00 | 0.00 | 3511. | 3650. |
| 21 OCT 1200 | 36 | 0.00 | 0.00 | 0.00 | 3454. | 3515. |
| 21 OCT 1300 | 37 | 0.00 | 0.00 | 0.00 | 3327. | 3294. |
| 21 OCT 1400 | 38 | 0.00 | 0.00 | 0.00 | 3157. | 3106. |
| 21 OCT 1500 | 39 | 0.00 | 0.00 | 0.00 | 2971. | 2893. |
| 21 OCT 1600 | 40 | 0.00 | 0.00 | 0.00 | 2781. | 2698. |
| 21 OCT 1700 | 41 | 0.00 | 0.00 | 0.00 | 2595. | 2522. |
| 21 OCT 1800 | 42 | 0.00 | 0.00 | 0.00 | 2420. | 2313. |
| 21 OCT 1900 | 43 | 0.00 | 0.00 | 0.00 | 2257. | 2050. |
| 21 OCT 2000 | 44 | 0.00 | 0.00 | 0.00 | 2106. | 1745. |
| 21 OCT 2100 | 45 | 0.00 | 0.00 | 0.00 | 1964. | 1461. |
| 21 OCT 2200 | 46 | 0.00 | 0.00 | 0.00 | 1833. | 1233. |
| 21 OCT 2300 | 47 | 0.00 | 0.00 | 0.00 | 1710. | 1068. |
| 22 OCT 0000 | 48 | 0.00 | 0.00 | 0.00 | 1596. | 957. |
| 22 OCT 0100 | 49 | 0.00 | 0.00 | 0.00 | 1489. | 877. |
| 22 OCT 0200 | 50 | 0.00 | 0.00 | 0.00 | 1390. | 819. |
| 22 OCT 0300 | 51 | 0.00 | 0.00 | 0.00 | 1297. | 770. |
| 22 OCT 0400 | 52 | 0.00 | 0.00 | 0.00 | 1211. | 735. |
| 22 OCT 0500 | 53 | 0.00 | 0.00 | 0.00 | 1131. | 703. |
| 22 OCT 0600 | 54 | 0.00 | 0.00 | 0.00 | 1056. | 676. |
| 22 OCT 0700 | 55 | 0.00 | 0.00 | 0.00 | 980. | 649. |
| 22 OCT 0800 | 56 | 0.00 | 0.00 | 0.00 | 921. | 628. |
| 22 OCT 0900 | 57 | 0.00 | 0.00 | 0.00 | 860. | 608. |
| 22 OCT 1000 | 58 | 0.00 | 0.00 | 0.00 | 804. | 588. |
| 22 OCT 1100 | 59 | 0.00 | 0.00 | 0.00 | 751. | 568. |
| 22 OCT 1200 | 60 | 0.00 | 0.00 | 0.00 | 702. | 548. |
| 22 OCT 1300 | 61 | 0.00 | 0.00 | 0.00 | 656. | 532. |
| 22 OCT 1400 | 62 | 0.00 | 0.00 | 0.00 | 613. | 513. |
| 22 OCT 1500 | 63 | 0.00 | 0.00 | 0.00 | 574. | 503. |
| 22 OCT 1600 | 64 | 0.00 | 0.00 | 0.00 | 537. | 489. |
| 22 OCT 1700 | 65 | 0.00 | 0.00 | 0.00 | 502. | 475. |
| 22 OCT 1800 | 66 | 0.00 | 0.00 | 0.00 | 470. | 461. |
| 22 OCT 1900 | 67 | 0.00 | 0.00 | 0.00 | 440. | 450. |
| 22 OCT 2000 | 68 | 0.00 | 0.00 | 0.00 | 411. | 438. |
| 22 OCT 2100 | 69 | 0.00 | 0.00 | 0.00 | 385. | 432. |
| 22 OCT 2200 | 70 | 0.00 | 0.00 | 0.00 | 361. | 420. |
| 22 OCT 2300 | 71 | 0.00 | 0.00 | 0.00 | 339. | 411. |
| 23 OCT 0000 | 72 | 0.00 | 0.00 | 0.00 | 333. | 402. |
| 23 OCT 0100 | 73 | 0.00 | 0.00 | 0.00 | 327. | 393. |
| 23 OCT 0200 | 74 | 0.00 | 0.00 | 0.00 | 321. | 387. |
| 23 OCT 0300 | 75 | 0.00 | 0.00 | 0.00 | 315. | 380. |
| 23 OCT 0400 | 76 | 0.00 | 0.00 | 0.00 | 309. | 375. |
| 23 OCT 0500 | 77 | 0.00 | 0.00 | 0.00 | 303. | 368. |
| 23 OCT 0600 | 78 | 0.00 | 0.00 | 0.00 | 297. | 362. |
| 23 OCT 0700 | 79 | 0.00 | 0.00 | 0.00 | 292. | 358. |
| 23 OCT 0800 | 80 | 0.00 | 0.00 | 0.00 | 286. | 350. |
| 23 OCT 0900 | 81 | 0.00 | 0.00 | 0.00 | 281. | 345. |
| 23 OCT 1000 | 82 | 0.00 | 0.00 | 0.00 | 276. | 340. |
| 23 OCT 1100 | 83 | 0.00 | 0.00 | 0.00 | 271. | 336. |
| 23 OCT 1200 | 84 | 0.00 | 0.00 | 0.00 | 265. | 332. |
| 23 OCT 1300 | 85 | 0.00 | 0.00 | 0.00 | 260. | 328. |
| 23 OCT 1400 | 86 | 0.00 | 0.00 | 0.00 | 256. | 324. |
| 23 OCT 1500 | 87 | 0.00 | 0.00 | 0.00 | 251. | 320. |
| 23 OCT 1600 | 88 | 0.00 | 0.00 | 0.00 | 246. | 316. |
| 23 OCT 1700 | 89 | 0.00 | 0.00 | 0.00 | 241. | 312. |
| 23 OCT 1800 | 90 | 0.00 | 0.00 | 0.00 | 237. | 310. |
| 23 OCT 1900 | 91 | 0.00 | 0.00 | 0.00 | 233. | 306. |
| 23 OCT 2000 | 92 | 0.00 | 0.00 | 0.00 | 228. | 302. |
| 23 OCT 2100 | 93 | 0.00 | 0.00 | 0.00 | 224. | 298. |
| 23 OCT 2200 | 94 | 0.00 | 0.00 | 0.00 | 220. | 294. |
| 23 OCT 2300 | 95 | 0.00 | 0.00 | 0.00 | 216. | 290. |
| 24 OCT 0000 | 96 | 0.00 | 0.00 | 0.00 | 212. | 288. |
| 24 OCT 0100 | 97 | 0.00 | 0.00 | 0.00 | 208. | 284. |
| 24 OCT 0200 | 98 | 0.00 | 0.00 | 0.00 | 204. | 282. |
| 24 OCT 0300 | 99 | 0.00 | 0.00 | 0.00 | 200. | 278. |
| 24 OCT 0400 | 100 | 0.00 | 0.00 | 0.00 | 196. | 276. |
| 24 OCT 0500 | 101 | 0.00 | 0.00 | 0.00 | 192. | 274. |

TOTAL RAINFALL = 2.25, TOTAL LOSS = 0.00, TOTAL EXCESS = 2.25

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 100.00-HR |
|---|---|---|---|---|---|---|
| 3511. | 34.00 | (CFS) | 3400. | 2583. | 1261. | 958. |
| | | (INCHES) | 0.530 | 1.609 | 2.357 | 2.487 |
| | | (AC-FT) | 1686. | 5123. | 7505. | 7918. |

CUMULATIVE AREA = 59.70 SQ MI




(-) LIMITS OF OPTIMIZATION

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                                            HEC-1 INPUT                                                   PAGE  1

 LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

    1           ID        BUTTERNUT CREEK 9-26-77
    2           ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)

    3           IT      60 26SEP77    0100      68
    4           IO       1       2
    5           OU       6      25
    6           PG      NB     .86
    7           PG      ED
    8           PI     .00     .00     .00     .00     .01     .37     .10     .07     .08     .07
    9           PI     .05     .00     .00     .00     .00     .00     .14     .01     .00     .00
   10           PG    ED3N
   11           PI     .00     .00     .00     .00     .00     .00     .20     .10     .10     .10
   12           PI     .20     .00     .00     .00     .10     .20     .00     .10     .00     .00

   13           KK  MORRIS
   14           QO     420     411     402     396     390     387     405     450     528     645
   15           QO     853    1145    1426    1646    1844    1970    2020    1980    1880    1781
   16           QO    1700    1646    1592    1538    1444    1316    1201    1105    1023     960
   17           QO     902     841     797     750     717     685     663     636     620     604
   18           QO     588     572     556     540     528     513     506     496     489     481
   19           QO     471     464     457     450     444     438     432     426     423     417
   20           QO     414     411     405     402     396     393     390     387       0       0
   21           PT      NB      ED    ED3N
   22           PW     .30     .58     .12
   23           PR      ED    ED3N       0       0       0
   24           PW     .88     .12      .0      .0      .0
   25           BA    59.7      0.
   26           BF    420.    440.  1.0191
   27           UC    -10.     -8.
   28           LU     -0.     -0.
   29           ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 6 THROUGH 25)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.912 | | 10.34 | | | |
| COMPUTED HYDROGRAPH | 27459. | 0.713 | 1373. | 17.36 | 7.02 | 1928. | 16.00 |
| OBSERVED HYDROGRAPH | 26880. | 0.698 | 1344. | 17.36 | 7.02 | 2020. | 16.00 |
| DIFFERENCE | 579. | 0.015 | 29. | -0.00 | -0.00 | -92. | 0.00 |
| PERCENT DIFFERENCE | 2.15 | | | | -0.01 | -4.53 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 70. | AVERAGE ABSOLUTE ERROR | 59. |
| OBJECTIVE FUNCTION | 70. | AVERAGE PERCENT ABSOLUTE ERROR | 5.22 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 68)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.912 | | 10.34 | | | |
| COMPUTED HYDROGRAPH | 53767. | 1.396 | 791. | 27.33 | 16.99 | 1928. | 16.00 |
| OBSERVED HYDROGRAPH | 54608. | 1.417 | 803. | 28.79 | 18.45 | 2020. | 16.00 |
| DIFFERENCE | -841. | -0.022 | -12. | -1.46 | -1.46 | -92. | 0.00 |
| PERCENT DIFFERENCE | -1.54 | | | | -7.89 | -4.53 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 95. | AVERAGE ABSOLUTE ERROR | 81. |
| OBJECTIVE FUNCTION | 98. | AVERAGE PERCENT ABSOLUTE ERROR | 13.98 |

UNIT HYDROGRAPH
61 END-OF-PERIOD ORDINATES

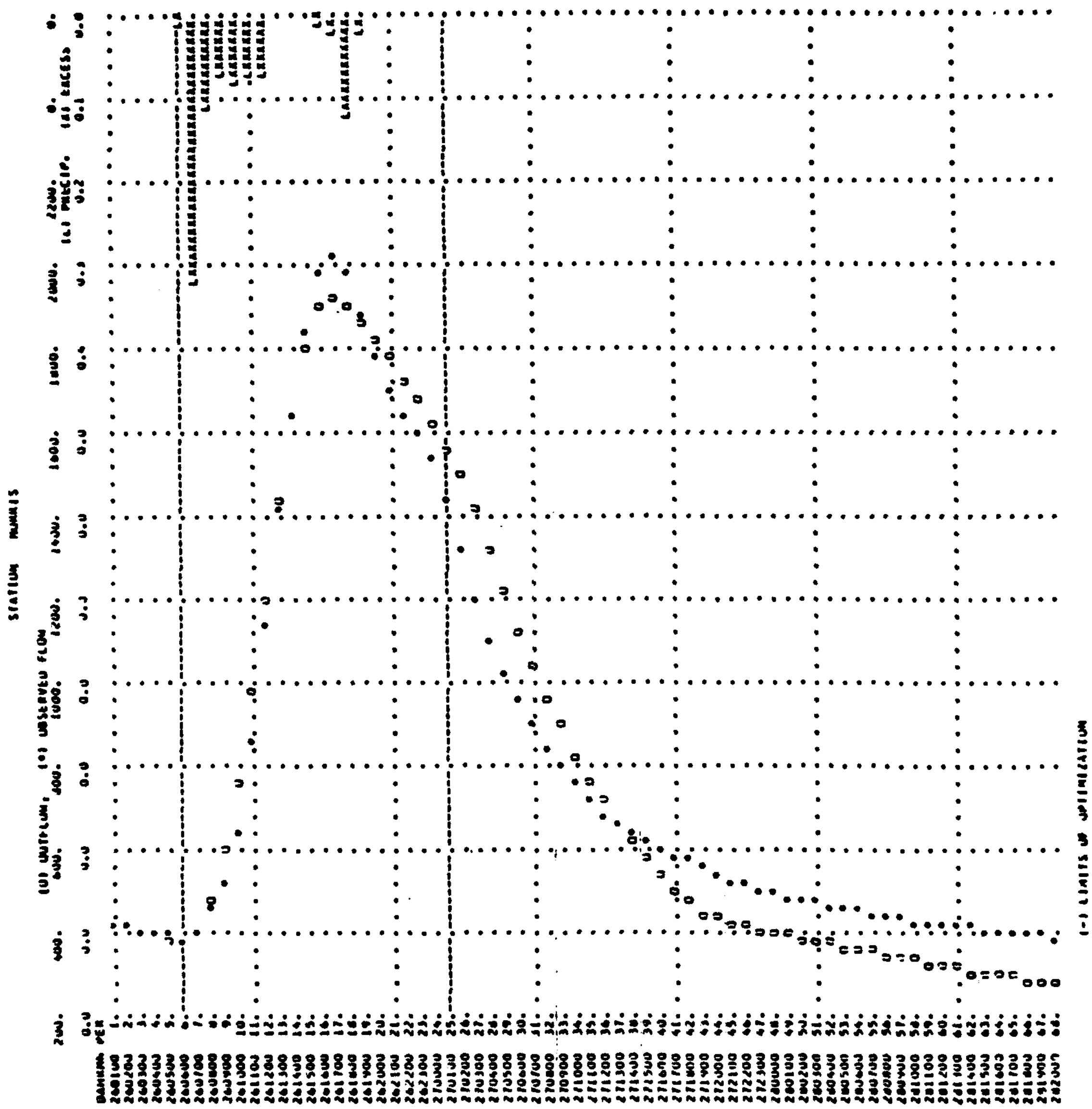
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 79. | 295. | 600. | 954. | 1340. | 1719. | 2031. | 2251. | 2372. | 2369. |
| 2225. | 2023. | 1839. | 1673. | 1521. | 1383. | 1257. | 1143. | 1039. | 945. |
| 859. | 781. | 710. | 646. | 587. | 534. | 486. | 441. | 401. | 365. |
| 332. | 302. | 274. | 249. | 227. | 206. | 188. | 170. | 155. | 141. |
| 128. | 117. | 106. | 96. | 88. | 80. | 72. | 66. | 60. | 54. |
| 49. | 45. | 41. | 37. | 34. | 31. | 28. | 25. | 23. | 21. |
| 19. | | | | | | | | | |

HYDROGRAPH AT STATION MORRIS

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 SEP 0100 | 1 | 0.00 | 0.00 | 0.00 | 420. | 420. | 27 SEP 1100 | 35 | 0.00 | 0.00 | 0.00 | 767. | 717. |
| 26 SEP 0200 | 2 | 0.00 | 0.00 | 0.00 | 412. | 411. | 27 SEP 1200 | 36 | 0.00 | 0.00 | 0.00 | 713. | 685. |
| 26 SEP 0300 | 3 | 0.00 | 0.00 | 0.00 | 404. | 402. | 27 SEP 1300 | 37 | 0.00 | 0.00 | 0.00 | 664. | 663. |
| 26 SEP 0400 | 4 | 0.00 | 0.00 | 0.00 | 397. | 396. | 27 SEP 1400 | 38 | 0.00 | 0.00 | 0.00 | 619. | 636. |
| 26 SEP 0500 | 5 | 0.00 | 0.00 | 0.00 | 389. | 390. | 27 SEP 1500 | 39 | 0.00 | 0.00 | 0.00 | 578. | 620. |
| 26 SEP 0600 | 6 | 0.01 | 0.00 | 0.01 | 383. | 387. | 27 SEP 1600 | 40 | 0.00 | 0.00 | 0.00 | 540. | 604. |
| 26 SEP 0700 | 7 | 0.32 | 0.00 | 0.32 | 403. | 405. | 27 SEP 1700 | 41 | 0.00 | 0.00 | 0.00 | 506. | 588. |
| 26 SEP 0800 | 8 | 0.11 | 0.00 | 0.11 | 477. | 450. | 27 SEP 1800 | 42 | 0.00 | 0.00 | 0.00 | 474. | 572. |
| 26 SEP 0900 | 9 | 0.07 | 0.00 | 0.07 | 600. | 528. | 27 SEP 1900 | 43 | 0.00 | 0.00 | 0.00 | 445. | 556. |
| 26 SEP 1000 | 10 | 0.08 | 0.00 | 0.08 | 767. | 645. | 27 SEP 2000 | 44 | 0.00 | 0.00 | 0.00 | 433. | 540. |
| 26 SEP 1100 | 11 | 0.07 | 0.00 | 0.07 | 972. | 853. | 27 SEP 2100 | 45 | 0.00 | 0.00 | 0.00 | 425. | 528. |
| 26 SEP 1200 | 12 | 0.07 | 0.00 | 0.07 | 1204. | 1145. | 27 SEP 2200 | 46 | 0.00 | 0.00 | 0.00 | 417. | 513. |
| 26 SEP 1300 | 13 | 0.00 | 0.00 | 0.00 | 1435. | 1426. | 27 SEP 2300 | 47 | 0.00 | 0.00 | 0.00 | 409. | 506. |
| 26 SEP 1400 | 14 | 0.00 | 0.00 | 0.00 | 1640. | 1646. | 28 SEP 0000 | 48 | 0.00 | 0.00 | 0.00 | 402. | 496. |
| 26 SEP 1500 | 15 | 0.00 | 0.00 | 0.00 | 1803. | 1844. | 28 SEP 0100 | 49 | 0.00 | 0.00 | 0.00 | 394. | 489. |
| 26 SEP 1600 | 16 | 0.01 | 0.00 | 0.01 | 1904. | 1970. | 28 SEP 0200 | 50 | 0.00 | 0.00 | 0.00 | 387. | 481. |
| 26 SEP 1700 | 17 | 0.02 | 0.00 | 0.02 | 1928. | 2020. | 28 SEP 0300 | 51 | 0.00 | 0.00 | 0.00 | 380. | 471. |
| 26 SEP 1800 | 18 | 0.12 | 0.00 | 0.12 | 1905. | 1980. | 28 SEP 0400 | 52 | 0.00 | 0.00 | 0.00 | 372. | 464. |
| 26 SEP 1900 | 19 | 0.02 | 0.00 | 0.02 | 1869. | 1880. | 28 SEP 0500 | 53 | 0.00 | 0.00 | 0.00 | 365. | 457. |
| 26 SEP 2000 | 20 | 0.00 | 0.00 | 0.00 | 1824. | 1781. | 28 SEP 0600 | 54 | 0.00 | 0.00 | 0.00 | 359. | 450. |
| 26 SEP 2100 | 21 | 0.00 | 0.00 | 0.00 | 1772. | 1700. | 28 SEP 0700 | 55 | 0.00 | 0.00 | 0.00 | 352. | 444. |
| 26 SEP 2200 | 22 | 0.00 | 0.00 | 0.00 | 1720. | 1646. | 28 SEP 0800 | 56 | 0.00 | 0.00 | 0.00 | 345. | 438. |
| 26 SEP 2300 | 23 | 0.00 | 0.00 | 0.00 | 1671. | 1592. | 28 SEP 0900 | 57 | 0.00 | 0.00 | 0.00 | 339. | 432. |
| 27 SEP 0000 | 24 | 0.00 | 0.00 | 0.00 | 1620. | 1538. | 28 SEP 1000 | 58 | 0.00 | 0.00 | 0.00 | 332. | 426. |
| 27 SEP 0100 | 25 | 0.00 | 0.00 | 0.00 | 1561. | 1444. | 28 SEP 1100 | 59 | 0.00 | 0.00 | 0.00 | 326. | 423. |
| 27 SEP 0200 | 26 | 0.00 | 0.00 | 0.00 | 1493. | 1316. | 28 SEP 1200 | 60 | 0.00 | 0.00 | 0.00 | 320. | 417. |
| 27 SEP 0300 | 27 | 0.00 | 0.00 | 0.00 | 1410. | 1201. | 28 SEP 1300 | 61 | 0.00 | 0.00 | 0.00 | 314. | 414. |
| 27 SEP 0400 | 28 | 0.00 | 0.00 | 0.00 | 1314. | 1105. | 28 SEP 1400 | 62 | 0.00 | 0.00 | 0.00 | 308. | 411. |
| 27 SEP 0500 | 29 | 0.00 | 0.00 | 0.00 | 1214. | 1023. | 28 SEP 1500 | 63 | 0.00 | 0.00 | 0.00 | 302. | 405. |
| 27 SEP 0600 | 30 | 0.00 | 0.00 | 0.00 | 1122. | 960. | 28 SEP 1600 | 64 | 0.00 | 0.00 | 0.00 | 297. | 402. |
| 27 SEP 0700 | 31 | 0.00 | 0.00 | 0.00 | 1037. | 902. | 28 SEP 1700 | 65 | 0.00 | 0.00 | 0.00 | 291. | 396. |
| 27 SEP 0800 | 32 | 0.00 | 0.00 | 0.00 | 960. | 841. | 28 SEP 1800 | 66 | 0.00 | 0.00 | 0.00 | 286. | 393. |
| 27 SEP 0900 | 33 | 0.00 | 0.00 | 0.00 | 890. | 797. | 28 SEP 1900 | 67 | 0.00 | 0.00 | 0.00 | 280. | 390. |
| 27 SEP 1000 | 34 | 0.00 | 0.00 | 0.00 | 826. | 750. | 28 SEP 2000 | 68 | 0.00 | 0.00 | 0.00 | 275. | 387. |

TOTAL RAINFALL = 0.91, TOTAL LOSS = 0.00, TOTAL EXCESS = 0.91

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 67.00-HR |
|---|---|---|---|---|---|---|
| 1928. | 16.00 | (CFS) | 1870. | 1461. | 797. | 797. |
| | | (INCHES) | 0.291 | 0.910 | 1.387 | 1.387 |
| | | (AC-FT) | 927. | 2898. | 4415. | 4415. |



HEC-1 INPUT 

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1       ID        BUTTERNUT CREEK 10-17-77
  2       ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)

  3       IT      60 16OCT77     0100      86
  4       IO       1       2
  5       OU      20      50
  6       PG      NB    2.76
  7       PG      ED
  8       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .02
  9       PI     .01     .01     .01     .00     .00     .00     .00     .01     .00     .00
 10       PI     .11     .33     .34     .09     .24     .19     .25     .23     .09     .05
 11       PI     .21     .17     .13     .13     .08     .05     .08     .04     .02     .00
 12       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 13       PG    ED3N
 14       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 15       PI     .00     .10     .00     .00     .00     .00     .00     .00     .00     .00
 16       PI     .00     .10     .30     .30     .20     .20     .10     .30     .20     .10
 17       PI     .10     .00     .10     .00     .10     .00     .10     .10     .00     .10
 18       PI     .00     .00     .10     .00     .00     .00     .00     .00     .00     .00

 19       KK  MORRIS
 20       QO     306     298     290     282     276     270     266     262     258     257
 21       QO     253     252     252     250     248     246     246     245     245     243
 22       QO     243     243     250     282     368     588    1097    1781    2467    3166
 23       QO    3822    4465    5100    5620    5920    5940    5980    5860    5760    5600
 24       QO    5400    5220    4980    4750    4510    4315    4105    3902    3719    3531
 25       QO    3348    3172    2989    2813    2643    2483    2319    2179    2034    1906
 26       QO    1792    1691    1583    1501    1440    1377    1325    1277    1237    1198
 27       QO    1160    1130    1094    1058    1023     995     968     942     916     890
 28       QO     865     847     823     805     793     781       0       0       0       0
 29       PT      NB      ED    ED3N
 30       PW     .30     .58     .12
 31       PR      ED    ED3N
 32       PW     .88     .12
 33       BA    59.7      0.
 34       BF    306.    850.  1.0191
 35       UC    -12.     -6.
 36       LU     -0.     -0.
 37       ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 20 THROUGH 50)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.816 | | 28.44 | | | |
| COMPUTED HYDROGRAPH | 103309. | 2.682 | 3333. | 38.22 | 9.77 | 5917. | 37.00 |
| OBSERVED HYDROGRAPH | 109227. | 2.835 | 3523. | 38.79 | 10.35 | 5980. | 36.00 |
| DIFFERENCE | -5918. | -0.154 | -191. | -0.57 | -0.57 | -63. | 1.00 |
| PERCENT DIFFERENCE | -5.42 | | | | -5.55 | -1.05 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 472. | AVERAGE ABSOLUTE ERROR | 354. |
| OBJECTIVE FUNCTION | 480. | AVERAGE PERCENT ABSOLUTE ERROR | 24.76 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 86)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.816 | | 28.44 | | | |
| COMPUTED HYDROGRAPH | 135586. | 3.519 | 1577. | 42.42 | 13.98 | 5917. | 37.00 |
| OBSERVED HYDROGRAPH | 169626. | 4.403 | 1972. | 46.12 | 17.68 | 5980. | 36.00 |
| DIFFERENCE | -34041. | -0.884 | -396. | -3.70 | -3.70 | -63. | 1.00 |
| PERCENT DIFFERENCE | -20.07 | | | | -20.93 | -1.05 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 662. | AVERAGE ABSOLUTE ERROR | 460. |
| OBJECTIVE FUNCTION | 733. | AVERAGE PERCENT ABSOLUTE ERROR | 37.60 |

UNIT HYDROGRAPH
33 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 95. | 366. | 676. | 1036. | 1501. | 1762. | 2112. | 2458. | 2694. | 2845. |
| 2901. | 2880. | 2761. | 2604. | 2311. | 1917. | 1535. | 1230. | 946. | 790. |
| 633. | 507. | 406. | 325. | 261. | 209. | 167. | 134. | 107. | 86. |
| 69. | 55. | 44. | | | | | | | |

HYDROGRAPH AT STATION MORRIS

| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|
| 16 | OCT | 0100 | 1 | 0.00 | 0.00 | 0.00 | 306. | 306. |
| 16 | OCT | 0200 | 2 | 0.00 | 0.00 | 0.00 | 300. | 298. |
| 16 | OCT | 0300 | 3 | 0.00 | 0.00 | 0.00 | 295. | 290. |
| 16 | OCT | 0400 | 4 | 0.00 | 0.00 | 0.00 | 289. | 282. |
| 16 | OCT | 0500 | 5 | 0.00 | 0.00 | 0.00 | 284. | 276. |
| 16 | OCT | 0600 | 6 | 0.00 | 0.00 | 0.00 | 278. | 270. |
| 16 | OCT | 0700 | 7 | 0.00 | 0.00 | 0.00 | 273. | 266. |
| 16 | OCT | 0800 | 8 | 0.00 | 0.00 | 0.00 | 268. | 262. |
| 16 | OCT | 0900 | 9 | 0.00 | 0.00 | 0.00 | 263. | 258. |
| 16 | OCT | 1000 | 10 | 0.00 | 0.00 | 0.00 | 258. | 257. |
| 16 | OCT | 1100 | 11 | 0.02 | 0.00 | 0.02 | 255. | 253. |
| 16 | OCT | 1200 | 12 | 0.01 | 0.00 | 0.01 | 255. | 252. |
| 16 | OCT | 1300 | 13 | 0.02 | 0.00 | 0.02 | 261. | 252. |
| 16 | OCT | 1400 | 14 | 0.01 | 0.00 | 0.01 | 271. | 250. |
| 16 | OCT | 1500 | 15 | 0.00 | 0.00 | 0.00 | 285. | 248. |
| 16 | OCT | 1600 | 16 | 0.00 | 0.00 | 0.00 | 300. | 246. |
| 16 | OCT | 1700 | 17 | 0.00 | 0.00 | 0.00 | 316. | 246. |
| 16 | OCT | 1800 | 18 | 0.00 | 0.00 | 0.00 | 331. | 245. |
| 16 | OCT | 1900 | 19 | 0.01 | 0.00 | 0.01 | 345. | 245. |
| 16 | OCT | 2000 | 20 | 0.00 | 0.00 | 0.00 | 358. | 243. |
| 16 | OCT | 2100 | 21 | 0.00 | 0.00 | 0.00 | 367. | 243. |
| 16 | OCT | 2200 | 22 | 0.10 | 0.00 | 0.10 | 381. | 243. |
| 16 | OCT | 2300 | 23 | 0.30 | 0.00 | 0.30 | 433. | 250. |
| 17 | OCT | 0000 | 24 | 0.33 | 0.00 | 0.33 | 567. | 282. |
| 17 | OCT | 0100 | 25 | 0.11 | 0.00 | 0.11 | 786. | 368. |
| 17 | OCT | 0200 | 26 | 0.23 | 0.00 | 0.23 | 1071. | 586. |
| 17 | OCT | 0300 | 27 | 0.19 | 0.00 | 0.19 | 1424. | 1097. |
| 17 | OCT | 0400 | 28 | 0.23 | 0.00 | 0.23 | 1855. | 1781. |
| 17 | OCT | 0500 | 29 | 0.24 | 0.00 | 0.24 | 2355. | 2467. |
| 17 | OCT | 0600 | 30 | 0.10 | 0.00 | 0.10 | 2912. | 3166. |
| 17 | OCT | 0700 | 31 | 0.06 | 0.00 | 0.06 | 3477. | 3822. |
| 17 | OCT | 0800 | 32 | 0.19 | 0.00 | 0.19 | 4018. | 4465. |
| 17 | OCT | 0900 | 33 | 0.15 | 0.00 | 0.15 | 4527. | 5100. |
| 17 | OCT | 1000 | 34 | 0.12 | 0.00 | 0.12 | 4990. | 5620. |
| 17 | OCT | 1100 | 35 | 0.11 | 0.00 | 0.11 | 5389. | 5920. |
| 17 | OCT | 1200 | 36 | 0.08 | 0.00 | 0.08 | 5697. | 5940. |
| 17 | OCT | 1300 | 37 | 0.04 | 0.00 | 0.04 | 5877. | 5980. |
| 17 | OCT | 1400 | 38 | 0.08 | 0.00 | 0.08 | 5917. | 5860. |
| 17 | OCT | 1500 | 39 | 0.05 | 0.00 | 0.05 | 5852. | 5760. |
| 17 | OCT | 1600 | 40 | 0.02 | 0.00 | 0.02 | 5714. | 5600. |
| 17 | OCT | 1700 | 41 | 0.01 | 0.00 | 0.01 | 5506. | 5400. |
| 17 | OCT | 1800 | 42 | 0.00 | 0.00 | 0.00 | 5231. | 5220. |
| 17 | OCT | 1900 | 43 | 0.00 | 0.00 | 0.00 | 4900. | 4980. |

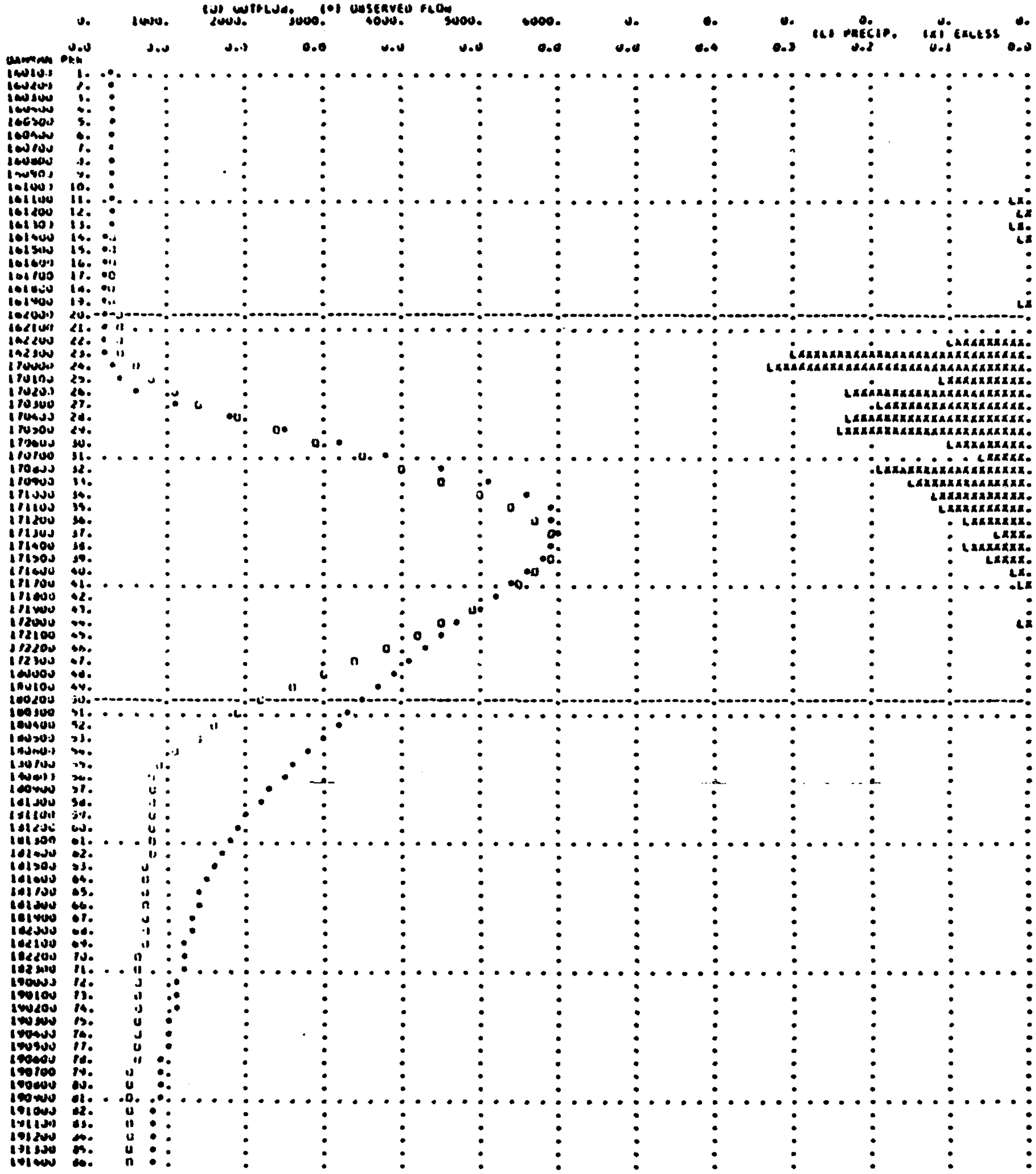
| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|
| 17 | OCT | 2000 | 44 | 0.01 | 0.00 | 0.01 | 4534. | 4750. |
| 17 | OCT | 2100 | 45 | 0.00 | 0.00 | 0.00 | 4160. | 4510. |
| 17 | OCT | 2200 | 46 | 0.00 | 0.00 | 0.00 | 3781. | 4315. |
| 17 | OCT | 2300 | 47 | 0.00 | 0.00 | 0.00 | 3388. | 4105. |
| 18 | OCT | 0000 | 48 | 0.00 | 0.00 | 0.00 | 2991. | 3902. |
| 18 | OCT | 0100 | 49 | 0.00 | 0.00 | 0.00 | 2606. | 3719. |
| 18 | OCT | 0200 | 50 | 0.00 | 0.00 | 0.00 | 2243. | 3531. |
| 18 | OCT | 0300 | 51 | 0.00 | 0.00 | 0.00 | 1913. | 3348. |
| 18 | OCT | 0400 | 52 | 0.00 | 0.00 | 0.00 | 1615. | 3172. |
| 18 | OCT | 0500 | 53 | 0.00 | 0.00 | 0.00 | 1351. | 2989. |
| 18 | OCT | 0600 | 54 | 0.00 | 0.00 | 0.00 | 1122. | 2813. |
| 18 | OCT | 0700 | 55 | 0.00 | 0.00 | 0.00 | 926. | 2643. |
| 18 | OCT | 0800 | 56 | 0.00 | 0.00 | 0.00 | 841. | 2483. |
| 18 | OCT | 0900 | 57 | 0.00 | 0.00 | 0.00 | 825. | 2319. |
| 18 | OCT | 1000 | 58 | 0.00 | 0.00 | 0.00 | 810. | 2179. |
| 18 | OCT | 1100 | 59 | 0.00 | 0.00 | 0.00 | 795. | 2034. |
| 18 | OCT | 1200 | 60 | 0.00 | 0.00 | 0.00 | 780. | 1906. |
| 18 | OCT | 1300 | 61 | 0.00 | 0.00 | 0.00 | 765. | 1792. |
| 18 | OCT | 1400 | 62 | 0.00 | 0.00 | 0.00 | 751. | 1691. |
| 18 | OCT | 1500 | 63 | 0.00 | 0.00 | 0.00 | 737. | 1583. |
| 18 | OCT | 1600 | 64 | 0.00 | 0.00 | 0.00 | 723. | 1501. |
| 18 | OCT | 1700 | 65 | 0.00 | 0.00 | 0.00 | 710. | 1440. |
| 18 | OCT | 1800 | 66 | 0.00 | 0.00 | 0.00 | 696. | 1377. |
| 18 | OCT | 1900 | 67 | 0.00 | 0.00 | 0.00 | 683. | 1325. |
| 18 | OCT | 2000 | 68 | 0.00 | 0.00 | 0.00 | 670. | 1277. |
| 18 | OCT | 2100 | 69 | 0.00 | 0.00 | 0.00 | 658. | 1237. |
| 18 | OCT | 2200 | 70 | 0.00 | 0.00 | 0.00 | 645. | 1198. |
| 18 | OCT | 2300 | 71 | 0.00 | 0.00 | 0.00 | 633. | 1160. |
| 19 | OCT | 0000 | 72 | 0.00 | 0.00 | 0.00 | 622. | 1130. |
| 19 | OCT | 0100 | 73 | 0.00 | 0.00 | 0.00 | 610. | 1094. |
| 19 | OCT | 0200 | 74 | 0.00 | 0.00 | 0.00 | 598. | 1058. |
| 19 | OCT | 0300 | 75 | 0.00 | 0.00 | 0.00 | 587. | 1023. |
| 19 | OCT | 0400 | 76 | 0.00 | 0.00 | 0.00 | 576. | 995. |
| 19 | OCT | 0500 | 77 | 0.00 | 0.00 | 0.00 | 565. | 968. |
| 19 | OCT | 0600 | 78 | 0.00 | 0.00 | 0.00 | 555. | 942. |
| 19 | OCT | 0700 | 79 | 0.00 | 0.00 | 0.00 | 544. | 916. |
| 19 | OCT | 0800 | 80 | 0.00 | 0.00 | 0.00 | 534. | 890. |
| 19 | OCT | 0900 | 81 | 0.00 | 0.00 | 0.00 | 524. | 865. |
| 19 | OCT | 1000 | 82 | 0.00 | 0.00 | 0.00 | 514. | 847. |
| 19 | OCT | 1100 | 83 | 0.00 | 0.00 | 0.00 | 505. | 823. |
| 19 | OCT | 1200 | 84 | 0.00 | 0.00 | 0.00 | 495. | 805. |
| 19 | OCT | 1300 | 85 | 0.00 | 0.00 | 0.00 | 486. | 793. |
| 19 | OCT | 1400 | 86 | 0.00 | 0.00 | 0.00 | 477. | 781. |

TOTAL RAINFALL = 2.82, TOTAL LOSS = 0.00, TOTAL EXCESS = 2.82

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 85.00-HR |
|---|---|---|---|---|---|---|
| 5917. | 37.00 | (CFS) | 5751. | 4155. | 1828. | 1591. |
| | | (INCHES) | 0.896 | 2.588 | 3.417 | 3.509 |
| | | (AC-FT) | 2852. | 8241. | 10873. | 11173. |

CUMULATIVE AREA = 59.70 SQ MI

STATION MORRIS




(-) LIMITS OF OPTIMIZATION

HEC-1 INPUT                                                                PAGE 1

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1       ID        CANASAWACTA CREEK    6-26-68
  2       ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3       IT      60 25JUN68    1400      93
  4       IO       1       2
  5       OU      14      30
  6       PG    PLYM
  7       PI     .02     .02     .04     .32     .02     .01     .21     .02     .01     .01
  8       PI     .03     .02     .18     .39     .12     .00     .03     .26     .42     .08
  9       PI     .02     .02     .02     .04     .01     .02     .01     .01     .01     .03
 10       PI     .01     .01     .00     .01     .00     .00     .00     .00     .00     .00
 11       PI     .00     .00     .10     .07     .03     .00     .00     .00     .03     .01
 12       PI     .00     .00     .00     .00     .00     .04     .24     .00     .04     .05
 13       PI     .24     .04     .02     .00     .00     .00     .00     .00     .00     .00

 14       KK   SPLYM
 15       QO      25      25      29      29      30      30      31      33      34      35
 16       QO      38      38      40      46      53     100     162     202     255     377
 17       QO     526     980    1632    1506    1394    1216    1060     920     791     719
 18       QO     647     604     564     540     512     491     464     470     452     440
 19       QO     422     410     399     394     394     410     428     452     470     470
 20       QO     464     456     446     434     416     404     394     428     456     519
 21       QO     588     737     890    1000    1120    1132    1072     980     900     830
 22       QO     764     710     656     620     560     556     526     512     491     477
 23       QO     458     446     434     428     416     410     399     393     383     377
 24       QO     372     366     361       0       0       0       0       0       0       0
 25       PT    PLYM
 26       PW    1.00
 27       PR    PLYM
 28       PW    1.00
 29       BA    57.9      0.
 30       BF     25.    +30.   1.024
 31       UC     -4.    -10.
 32       LU     -1.    -.05
 33       ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 14 THROUGH 30)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.932 | | 36.78 | | | |
| COMPUTED HYDROGRAPH | 11992. | 0.321 | 705. | 25.09 | -11.69 | 1532. | 23.00 |
| OBSERVED HYDROGRAPH | 11939. | 0.320 | 702. | 24.58 | -12.20 | 1632. | 22.00 |
| DIFFERENCE | 53. | 0.001 | 3. | 0.51 | 0.51 | -100. | 1.00 |
| PERCENT DIFFERENCE | 0.44 | | | | -4.18 | -6.12 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 126. | AVERAGE ABSOLUTE ERROR | 109. |
| OBJECTIVE FUNCTION | 122. | AVERAGE PERCENT ABSOLUTE ERROR | 36.58 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 93)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.932 | | 36.78 | | | |
| COMPUTED HYDROGRAPH | 40369. | 1.080 | 434. | 49.82 | 13.05 | 1532. | 23.00 |
| OBSERVED HYDROGRAPH | 46614. | 1.248 | 501. | 52.00 | 15.22 | 1632. | 22.00 |
| DIFFERENCE | -6245. | -0.167 | -67. | -2.17 | -2.17 | -100. | 1.00 |
| PERCENT DIFFERENCE | -13.40 | | | | -14.27 | -6.12 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 112. | AVERAGE ABSOLUTE ERROR | 92. |
| OBJECTIVE FUNCTION | 121. | AVERAGE PERCENT ABSOLUTE ERROR | 23.74 |

UNIT HYDROGRAPH
54 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 299. | 1114. | 2135. | 2683. | 3305. | 2762. | 2673. | 2230. | 2011. | 1819. |
| 1636. | 1475. | 1310. | 1250. | 1062. | 976. | 880. | 799. | 716. | 645. |
| 582. | 525. | 473. | 427. | 385. | 347. | 313. | 282. | 255. | 230. |
| 207. | 187. | 168. | 152. | 137. | 124. | 111. | 100. | 91. | 82. |
| 74. | 66. | 60. | 54. | 49. | 44. | 40. | 36. | 32. | 29. |
| 26. | 24. | 21. | 19. | | | | | | |

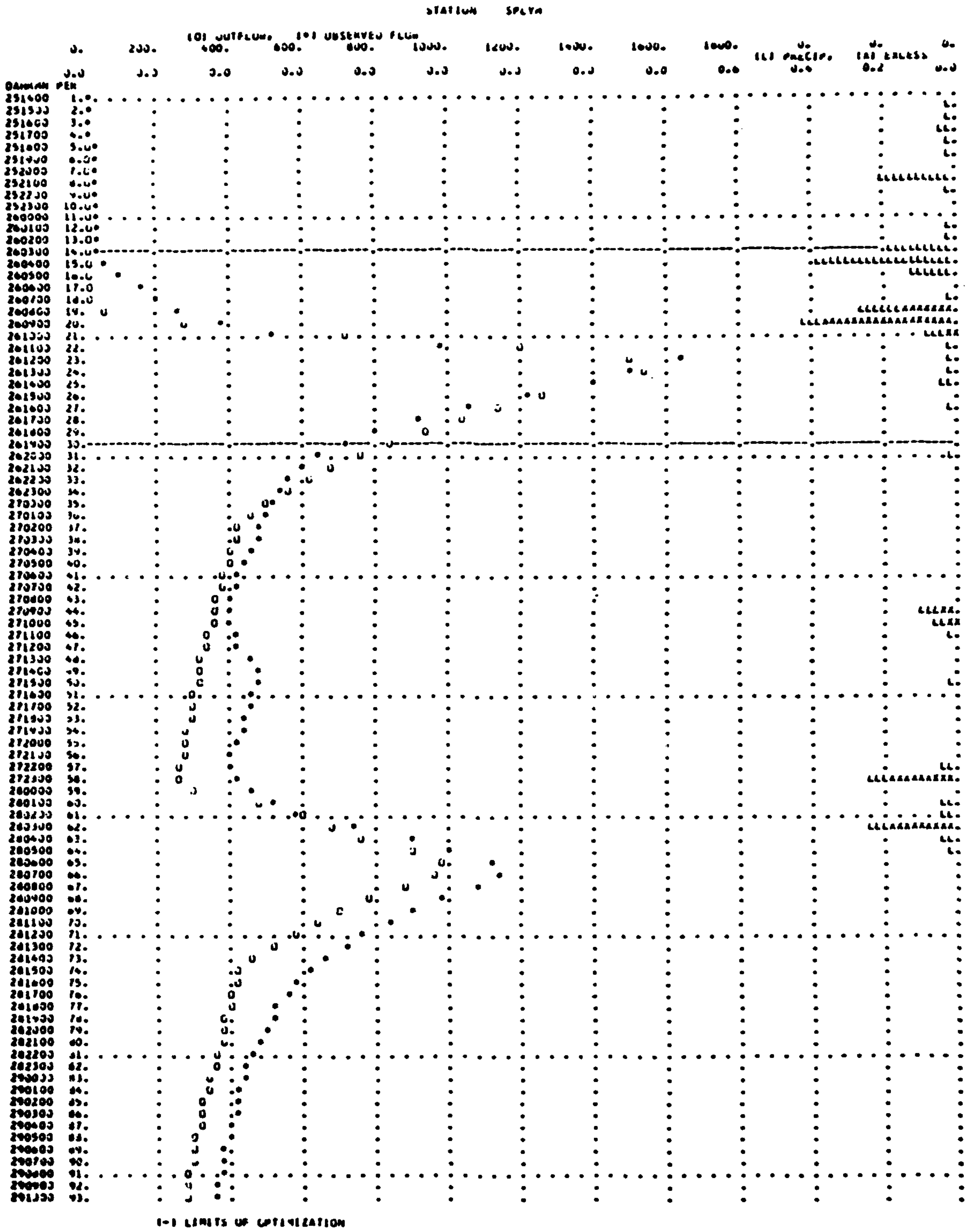
HYDROGRAPH AT STATION SPLYM

| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|
| 25 | JUN | 1400 | 1 | 0.00 | 0.00 | 0.00 | 25. | 25. |
| 25 | JUN | 1500 | 2 | 0.02 | 0.02 | 0.00 | 24. | 25. |
| 25 | JUN | 1600 | 3 | 0.02 | 0.02 | 0.00 | 24. | 29. |
| 25 | JUN | 1700 | 4 | 0.04 | 0.04 | 0.00 | 23. | 29. |
| 25 | JUN | 1800 | 5 | 0.02 | 0.02 | 0.00 | 23. | 30. |
| 25 | JUN | 1900 | 6 | 0.02 | 0.02 | 0.00 | 22. | 30. |
| 25 | JUN | 2000 | 7 | 0.01 | 0.01 | 0.00 | 22. | 31. |
| 25 | JUN | 2100 | 8 | 0.21 | 0.21 | 0.00 | 21. | 33. |
| 25 | JUN | 2200 | 9 | 0.02 | 0.02 | 0.00 | 21. | 34. |
| 25 | JUN | 2300 | 10 | 0.01 | 0.01 | 0.00 | 20. | 35. |
| 26 | JUN | 0000 | 11 | 0.01 | 0.01 | 0.00 | 20. | 38. |
| 26 | JUN | 0100 | 12 | 0.03 | 0.03 | 0.00 | 19. | 38. |
| 26 | JUN | 0200 | 13 | 0.02 | 0.02 | 0.00 | 19. | 43. |
| 26 | JUN | 0300 | 14 | 0.18 | 0.18 | 0.00 | 18. | 46. |
| 26 | JUN | 0400 | 15 | 0.39 | 0.39 | 0.00 | 18. | 53. |
| 26 | JUN | 0500 | 16 | 0.12 | 0.12 | 0.00 | 18. | 100. |
| 26 | JUN | 0600 | 17 | 0.00 | 0.00 | 0.00 | 17. | 162. |
| 26 | JUN | 0700 | 18 | 0.03 | 0.03 | 0.00 | 17. | 202. |
| 26 | JUN | 0800 | 19 | 0.26 | 0.12 | 0.14 | 57. | 255. |
| 26 | JUN | 0900 | 20 | 0.42 | 0.06 | 0.36 | 275. | 377. |
| 26 | JUN | 1000 | 21 | 0.38 | 0.06 | 0.32 | 713. | 528. |
| 26 | JUN | 1100 | 22 | 0.02 | 0.02 | 0.00 | 1200. | 980. |
| 26 | JUN | 1200 | 23 | 0.02 | 0.02 | 0.00 | 1508. | 1432. |
| 26 | JUN | 1300 | 24 | 0.02 | 0.02 | 0.00 | 1532. | 1506. |
| 26 | JUN | 1400 | 25 | 0.04 | 0.04 | 0.00 | 1403. | 1394. |
| 26 | JUN | 1500 | 26 | 0.01 | 0.01 | 0.00 | 1267. | 1216. |
| 26 | JUN | 1600 | 27 | 0.02 | 0.02 | 0.00 | 1144. | 1080. |
| 26 | JUN | 1700 | 28 | 0.01 | 0.01 | 0.00 | 1032. | 920. |
| 26 | JUN | 1800 | 29 | 0.01 | 0.01 | 0.00 | 932. | 791. |
| 26 | JUN | 1900 | 30 | 0.01 | 0.01 | 0.00 | 841. | 719. |
| 26 | JUN | 2000 | 31 | 0.03 | 0.03 | 0.00 | 760. | 647. |
| 26 | JUN | 2100 | 32 | 0.01 | 0.01 | 0.00 | 686. | 604. |
| 26 | JUN | 2200 | 33 | 0.01 | 0.01 | 0.00 | 620. | 564. |
| 26 | JUN | 2300 | 34 | 0.00 | 0.00 | 0.00 | 560. | 540. |
| 27 | JUN | 0000 | 35 | 0.01 | 0.01 | 0.00 | 506. | 512. |
| 27 | JUN | 0100 | 36 | 0.00 | 0.00 | 0.00 | 457. | 491. |
| 27 | JUN | 0200 | 37 | 0.00 | 0.00 | 0.00 | 428. | 484. |
| 27 | JUN | 0300 | 38 | 0.00 | 0.00 | 0.00 | 418. | 470. |
| 27 | JUN | 0400 | 39 | 0.00 | 0.00 | 0.00 | 406. | 452. |
| 27 | JUN | 0500 | 40 | 0.00 | 0.00 | 0.00 | 397. | 440. |
| 27 | JUN | 0600 | 41 | 0.00 | 0.00 | 0.00 | 387. | 422. |
| 27 | JUN | 0700 | 42 | 0.00 | 0.00 | 0.00 | 378. | 410. |
| 27 | JUN | 0800 | 43 | 0.00 | 0.00 | 0.00 | 370. | 399. |
| 27 | JUN | 0900 | 44 | 0.13 | 0.09 | 0.04 | 361. | 394. |
| 27 | JUN | 1000 | 45 | 0.07 | 0.06 | 0.01 | 352. | 394. |
| 27 | JUN | 1100 | 46 | 0.03 | 0.03 | 0.00 | 344. | 410. |
| 27 | JUN | 1200 | 47 | 0.00 | 0.00 | 0.00 | 336. | 428. |
| 27 | JUN | 1300 | 48 | 0.00 | 0.00 | 0.00 | 328. | 452. |
| 27 | JUN | 1400 | 49 | 0.00 | 0.00 | 0.00 | 321. | 470. |
| 27 | JUN | 1500 | 50 | 0.03 | 0.03 | 0.00 | 313. | 470. |
| 27 | JUN | 1600 | 51 | 0.01 | 0.01 | 0.00 | 306. | 464. |
| 27 | JUN | 1700 | 52 | 0.00 | 0.00 | 0.00 | 299. | 458. |
| 27 | JUN | 1800 | 53 | 0.00 | 0.00 | 0.00 | 292. | 446. |
| 27 | JUN | 1900 | 54 | 0.00 | 0.00 | 0.00 | 285. | 434. |
| 27 | JUN | 2000 | 55 | 0.00 | 0.00 | 0.00 | 278. | 418. |
| 27 | JUN | 2100 | 56 | 0.00 | 0.00 | 0.00 | 271. | 404. |
| 27 | JUN | 2200 | 57 | 0.04 | 0.04 | 0.00 | 265. | 394. |
| 27 | JUN | 2300 | 58 | 0.24 | 0.06 | 0.18 | 259. | 428. |
| 28 | JUN | 0000 | 59 | 0.00 | 0.00 | 0.00 | 302. | 458. |
| 28 | JUN | 0100 | 60 | 0.04 | 0.04 | 0.00 | 477. | 519. |
| 28 | JUN | 0200 | 61 | 0.05 | 0.05 | 0.00 | 604. | 588. |
| 28 | JUN | 0300 | 62 | 0.24 | 0.06 | 0.18 | 673. | 737. |
| 28 | JUN | 0400 | 63 | 0.04 | 0.04 | 0.00 | 766. | 890. |
| 28 | JUN | 0500 | 64 | 0.02 | 0.02 | 0.00 | 898. | 1000. |
| 28 | JUN | 0600 | 65 | 0.00 | 0.00 | 0.00 | 982. | 1120. |
| 28 | JUN | 0700 | 66 | 0.00 | 0.00 | 0.00 | 959. | 1132. |
| 28 | JUN | 0800 | 67 | 0.00 | 0.00 | 0.00 | 871. | 1072. |
| 28 | JUN | 0900 | 68 | 0.00 | 0.00 | 0.00 | 788. | 980. |
| 28 | JUN | 1000 | 69 | 0.00 | 0.00 | 0.00 | 709. | 930. |
| 28 | JUN | 1100 | 70 | 0.00 | 0.00 | 0.00 | 640. | 830. |
| 28 | JUN | 1200 | 71 | 0.00 | 0.00 | 0.00 | 578. | 764. |
| 28 | JUN | 1300 | 72 | 0.00 | 0.00 | 0.00 | 521. | 710. |
| 28 | JUN | 1400 | 73 | 0.00 | 0.00 | 0.00 | 468. | 656. |
| 28 | JUN | 1500 | 74 | 0.00 | 0.00 | 0.00 | 427. | 620. |
| 28 | JUN | 1600 | 75 | 0.00 | 0.00 | 0.00 | 417. | 580. |
| 28 | JUN | 1700 | 76 | 0.00 | 0.00 | 0.00 | 408. | 550. |
| 28 | JUN | 1800 | 77 | 0.00 | 0.00 | 0.00 | 398. | 520. |
| 28 | JUN | 1900 | 78 | 0.00 | 0.00 | 0.00 | 389. | 512. |
| 28 | JUN | 2000 | 79 | 0.00 | 0.00 | 0.00 | 380. | 491. |
| 28 | JUN | 2100 | 80 | 0.00 | 0.00 | 0.00 | 371. | 477. |
| 28 | JUN | 2200 | 81 | 0.00 | 0.00 | 0.00 | 362. | 458. |
| 28 | JUN | 2300 | 82 | 0.00 | 0.00 | 0.00 | 353. | 446. |
| 29 | JUN | 0000 | 83 | 0.00 | 0.00 | 0.00 | 345. | 434. |
| 29 | JUN | 0100 | 84 | 0.00 | 0.00 | 0.00 | 337. | 428. |
| 29 | JUN | 0200 | 85 | 0.00 | 0.00 | 0.00 | 329. | 416. |
| 29 | JUN | 0300 | 86 | 0.00 | 0.00 | 0.00 | 321. | 410. |
| 29 | JUN | 0400 | 87 | 0.00 | 0.00 | 0.00 | 314. | 399. |
| 29 | JUN | 0500 | 88 | 0.00 | 0.00 | 0.00 | 307. | 393. |
| 29 | JUN | 0600 | 89 | 0.00 | 0.00 | 0.00 | 299. | 381. |
| 29 | JUN | 0700 | 90 | 0.00 | 0.00 | 0.00 | 292. | 377. |
| 29 | JUN | 0800 | 91 | 0.00 | 0.00 | 0.00 | 286. | 372. |
| 29 | JUN | 0900 | 92 | 0.00 | 0.00 | 0.00 | 279. | 366. |
| 29 | JUN | 1000 | 93 | 0.00 | 0.00 | 0.00 | 272. | 361. |

TOTAL RAINFALL = 3.04, TOTAL LOSS = 2.11, TOTAL EXCESS = 0.93

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 92.00-HR |
|---|---|---|---|---|---|---|
| 1512. | 23.00 | (CFS) | 1328. | 761. | 547. | 437. |
| | | (INCHES) | 0.213 | 0.489 | 1.054 | 1.076 |
| | | (AC-FT) | 659. | 1519. | 3258. | 3324. |

CUMULATIVE AREA = 57.90 SQ MI


STATION SPLYN
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS
(-) LIMITS OF OPTIMIZATION

```
                                   HEC-1 INPUT                                          PAGE  1

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID        CANASAWACTA CREEK     11-18-68
  2         ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3         IT      60 18NOV68    0100      66
  4         IO       1       2
  5         OO       1      31
  6         PG    PLYM
  7         PI     .01     .07     .13     .05     .02     .01     .04     .02     .02     .00
  8         PI     .02     .00     .00     .12     .09     .08     .04     .14     .09     .07
  9         PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 10         PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .02
 11         PI     .04     .03     .02     .00     .00     .00     .00     .00     .00     .00

 12         KK   SPLYM
 13         QO     255     260     285     315     399     505     556     701     755     810
 14         QO     810     820     830     850    1000    1192    1408    1664    1792    1948
 15         QO    2002    2056    1966    1876    1680    1506    1338    1160    1096    1012
 16         QO     960     900     850     800     764     719     692     665     656     638
 17         QO     612     580     564     548     540     533     526     512     498     477
 18         QO     470     466     454     442     436     422     416     404     399     388
 19         QO     377     366     372     372     366     360       0       0       0       0
 20         PT    PLYM
 21         PW    1.00
 22         PK    PLYM
 23         PW    1.00
 24         BA    57.9      0.
 25         BF    255.    580.   1.024
 26         UC     -4.     -8.
 27         LU     -0.     -0.
 28         ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 1 THROUGH 31)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.130 | | 15.97 | | | |
| COMPUTED HYDROGRAPH | 35348. | 0.946 | 1140. | 18.49 | 2.52 | 2010. | 21.00 |
| OBSERVED HYDROGRAPH | 33827. | 0.905 | 1091. | 19.35 | 3.37 | 2056. | 21.00 |
| DIFFERENCE | 1521. | 0.041 | 49. | -0.85 | -0.85 | -46. | 0.00 |
| PERCENT DIFFERENCE | 4.50 | | | | -25.33 | -2.23 | |

STANDARD ERROR 183.    AVERAGE ABSOLUTE ERROR 132.
OBJECTIVE FUNCTION 168.    AVERAGE PERCENT ABSOLUTE ERROR 18.97

### STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 66)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.130 | | 15.97 | | | |
| COMPUTED HYDROGRAPH | 53863. | 1.442 | 816. | 28.29 | 12.31 | 2010. | 21.00 |
| OBSERVED HYDROGRAPH | 52411. | 1.403 | 794. | 28.92 | 12.94 | 2056. | 21.00 |
| DIFFERENCE | 1452. | 0.039 | 22. | -0.63 | -0.63 | -46. | 0.00 |
| PERCENT DIFFERENCE | 2.77 | | | | -4.85 | -2.23 | |

STANDARD ERROR 131.    AVERAGE ABSOLUTE ERROR 87.
OBJECTIVE FUNCTION 140.    AVERAGE PERCENT ABSOLUTE ERROR 13.50

UNIT HYDROGRAPH
58 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 704. | 2233. | 3009. | 2827. | 2573. | 2341. | 2130. | 1939. | 1764. | 1606. |
| 1461. | 1330. | 1210. | 1101. | 1002. | 912. | 830. | 755. | 687. | 625. |
| 569. | 518. | 471. | 429. | 390. | 355. | 323. | 294. | 268. | 244. |
| 222. | 202. | 184. | 167. | 152. | 138. | 126. | 115. | 104. | 95. |
| 86. | 79. | 72. | 65. | 59. | 54. | 49. | 45. | 41. | 37. |
| 34. | 31. | 28. | 25. | 23. | 21. | 19. | 17. | | |

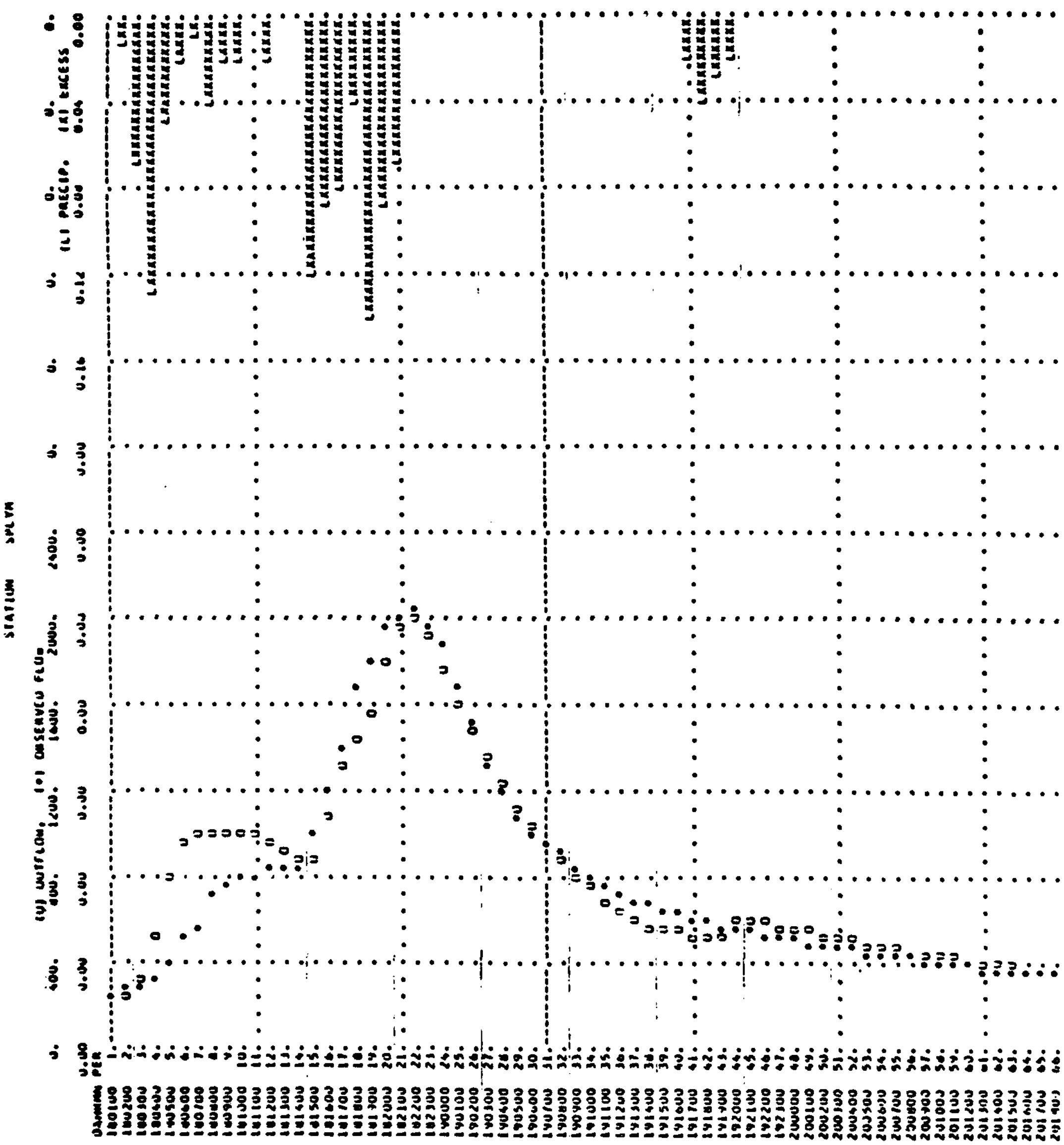
HYDROGRAPH AT STATION SPLYN

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 NOV 0100 | 1 | 0.00 | 0.00 | 0.00 | 255. | 255. | 19 NOV 1000 | 34 | 0.00 | 0.00 | 0.00 | 745. | 800. |
| 18 NOV 0200 | 2 | 0.01 | 0.00 | 0.01 | 256. | 260. | 19 NOV 1100 | 35 | 0.00 | 0.00 | 0.00 | 685. | 764. |
| 18 NOV 0300 | 3 | 0.07 | 0.00 | 0.07 | 315. | 285. | 19 NOV 1200 | 36 | 0.00 | 0.00 | 0.00 | 631. | 719. |
| 18 NOV 0400 | 4 | 0.13 | 0.00 | 0.13 | 515. | 315. | 19 NOV 1300 | 37 | 0.00 | 0.00 | 0.00 | 582. | 692. |
| 18 NOV 0500 | 5 | 0.05 | 0.00 | 0.05 | 796. | 399. | 19 NOV 1400 | 38 | 0.00 | 0.00 | 0.00 | 567. | 665. |
| 18 NOV 0600 | 6 | 0.02 | 0.00 | 0.02 | 967. | 505. | 19 NOV 1500 | 39 | 0.00 | 0.00 | 0.00 | 554. | 656. |
| 18 NOV 0700 | 7 | 0.01 | 0.00 | 0.01 | 994. | 556. | 19 NOV 1600 | 40 | 0.00 | 0.00 | 0.00 | 541. | 638. |
| 18 NOV 0800 | 8 | 0.04 | 0.00 | 0.04 | 988. | 701. | 19 NOV 1700 | 41 | 0.02 | 0.00 | 0.02 | 528. | 612. |
| 18 NOV 0900 | 9 | 0.02 | 0.00 | 0.02 | 1002. | 755. | 19 NOV 1800 | 42 | 0.04 | 0.00 | 0.04 | 516. | 580. |
| 18 NOV 1000 | 10 | 0.02 | 0.00 | 0.02 | 1012. | 810. | 19 NOV 1900 | 43 | 0.03 | 0.00 | 0.03 | 534. | 564. |
| 18 NOV 1100 | 11 | 0.00 | 0.00 | 0.00 | 990. | 810. | 19 NOV 2000 | 44 | 0.02 | 0.00 | 0.02 | 595. | 548. |
| 18 NOV 1200 | 12 | 0.02 | 0.00 | 0.02 | 949. | 820. | 19 NOV 2100 | 45 | 0.00 | 0.00 | 0.00 | 612. | 540. |
| 18 NOV 1300 | 13 | 0.00 | 0.00 | 0.00 | 911. | 830. | 19 NOV 2200 | 46 | 0.00 | 0.00 | 0.00 | 585. | 533. |
| 18 NOV 1400 | 14 | 0.00 | 0.00 | 0.00 | 861. | 850. | 19 NOV 2300 | 47 | 0.00 | 0.00 | 0.00 | 568. | 526. |
| 18 NOV 1500 | 15 | 0.12 | 0.00 | 0.12 | 882. | 1000. | 20 NOV 0000 | 48 | 0.00 | 0.00 | 0.00 | 555. | 512. |
| 18 NOV 1600 | 16 | 0.09 | 0.00 | 0.09 | 1069. | 1192. | 20 NOV 0100 | 49 | 0.00 | 0.00 | 0.00 | 542. | 498. |
| 18 NOV 1700 | 17 | 0.08 | 0.00 | 0.08 | 1302. | 1408. | 20 NOV 0200 | 50 | 0.00 | 0.00 | 0.00 | 529. | 477. |
| 18 NOV 1800 | 18 | 0.04 | 0.00 | 0.04 | 1451. | 1664. | 20 NOV 0300 | 51 | 0.00 | 0.00 | 0.00 | 517. | 470. |
| 18 NOV 1900 | 19 | 0.14 | 0.00 | 0.14 | 1580. | 1792. | 20 NOV 0400 | 52 | 0.00 | 0.00 | 0.00 | 504. | 464. |
| 18 NOV 2000 | 20 | 0.09 | 0.00 | 0.09 | 1781. | 1944. | 20 NOV 0500 | 53 | 0.00 | 0.00 | 0.00 | 493. | 454. |
| 18 NOV 2100 | 21 | 0.07 | 0.00 | 0.07 | 1965. | 2002. | 20 NOV 0600 | 54 | 0.00 | 0.00 | 0.00 | 481. | 442. |
| 18 NOV 2200 | 22 | 0.00 | 0.00 | 0.00 | 2010. | 2056. | 20 NOV 0700 | 55 | 0.00 | 0.00 | 0.00 | 470. | 436. |
| 18 NOV 2300 | 23 | 0.00 | 0.00 | 0.00 | 1916. | 1966. | 20 NOV 0800 | 56 | 0.00 | 0.00 | 0.00 | 459. | 422. |
| 19 NOV 0000 | 24 | 0.00 | 0.00 | 0.00 | 1760. | 1876. | 20 NOV 0900 | 57 | 0.00 | 0.00 | 0.00 | 448. | 416. |
| 19 NOV 0100 | 25 | 0.00 | 0.00 | 0.00 | 1611. | 1680. | 20 NOV 1000 | 58 | 0.00 | 0.00 | 0.00 | 438. | 404. |
| 19 NOV 0200 | 26 | 0.00 | 0.00 | 0.00 | 1476. | 1506. | 20 NOV 1100 | 59 | 0.00 | 0.00 | 0.00 | 427. | 399. |
| 19 NOV 0300 | 27 | 0.00 | 0.00 | 0.00 | 1353. | 1338. | 20 NOV 1200 | 60 | 0.00 | 0.00 | 0.00 | 417. | 388. |
| 19 NOV 0400 | 28 | 0.00 | 0.00 | 0.00 | 1240. | 1180. | 20 NOV 1300 | 61 | 0.00 | 0.00 | 0.00 | 407. | 377. |
| 19 NOV 0500 | 29 | 0.00 | 0.00 | 0.00 | 1137. | 1096. | 20 NOV 1400 | 62 | 0.00 | 0.00 | 0.00 | 398. | 366. |
| 19 NOV 0600 | 30 | 0.00 | 0.00 | 0.00 | 1044. | 1012. | 20 NOV 1500 | 63 | 0.00 | 0.00 | 0.00 | 389. | 372. |
| 19 NOV 0700 | 31 | 0.00 | 0.00 | 0.00 | 958. | 960. | 20 NOV 1600 | 64 | 0.00 | 0.00 | 0.00 | 379. | 372. |
| 19 NOV 0800 | 32 | 0.00 | 0.00 | 0.00 | 881. | 900. | 20 NOV 1700 | 65 | 0.00 | 0.00 | 0.00 | 371. | 366. |
| 19 NOV 0900 | 33 | 0.00 | 0.00 | 0.00 | 809. | 850. | 20 NOV 1800 | 66 | 0.00 | 0.00 | 0.00 | 362. | 360. |

TOTAL RAINFALL = 1.13, TOTAL LOSS = 0.00, TOTAL EXCESS = 1.13

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 65.00-HR |
|---|---|---|---|---|---|---|
| 2010. | 21.00 | (CFS) | 1838. | 1303. | 824. | 824. |
| | | (INCHES) | 0.295 | 0.837 | 1.433 | 1.433 |
| | | (AC-FT) | 911. | 2584. | 4426. | 4426. |

CUMULATIVE AREA = 57.90 SQ MI


STATION SPLVN
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS

HEC-1 INPUT



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LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1        ID       CANASAWACTA CREEK    6-24-69
  2        ID       UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3        IT      60  22JUN69    2200      70
  4        IO       1       2
  5        OU      25      36
  6        PG    PLYM
  7        PI     .01     .01     .00     .10     .00     .00     .00     .01     .13     .06
  8        PI     .02     .07     .11     .09     .20     .01     .00     .00     .00     .00
  9        PI     .00     .00     .06     .06     .17     .17     .67     .50     .60     .12
 10        PI     .08     .01     .00     .00     .01     .00     .00     .01     .01     .01

 11        KK   SPLYM
 12        QO      10      10      10       9       9       9       9       9      10      11
 13        QO      11      11      12      13      15      18      21      26      43      67
 14        QO      79      92      88      83      79      74      97     126     193    1060
 15        QO    1380    1760    1648    1536    1324    1144     950     782     674     572
 16        QO     505     446     404     382     345     320     300     280     265     251
 17        QO     238     230     221     213     206     199     191     188     184     181
 18        QO     174     171     167     164     161     158     155     152     146     143
 19        PT    PLYM
 20        PW    1.00
 21        PR    PLYM
 22        PW    1.00
 23        BA    57.9      0.
 24        BF     10.    200.   1.024
 25        UC     -4.    -10.
 26        LU     -1.     -1.
 27        ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 25 THROUGH 36)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.679 | | 29.59 | | | |
| COMPUTED HYDROGRAPH | 10366. | 0.277 | 864. | 32.92 | 3.32 | 1759. | 31.00 |
| OBSERVED HYDROGRAPH | 10421. | 0.279 | 868. | 32.69 | 3.10 | 1760. | 31.00 |
| DIFFERENCE | -55. | -0.001 | -5. | 0.23 | 0.23 | -1. | 0.00 |
| PERCENT DIFFERENCE | -0.52 | | | | 7.30 | -0.07 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 105. | AVERAGE ABSOLUTE ERROR | 84. |
| OBJECTIVE FUNCTION | 109. | AVERAGE PERCENT ABSOLUTE ERROR | 37.06 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 70)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.679 | | 29.59 | | | |
| COMPUTED HYDROGRAPH | 25268. | 0.676 | 361. | 41.11 | 11.52 | 1759. | 31.00 |
| OBSERVED HYDROGRAPH | 21214. | 0.568 | 303. | 39.65 | 10.06 | 1760. | 31.00 |
| DIFFERENCE | 4054. | 0.108 | 58. | 1.46 | 1.46 | -1. | 0.00 |
| PERCENT DIFFERENCE | 19.11 | | | | 14.54 | -0.07 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 135. | AVERAGE ABSOLUTE ERROR | 80. |
| OBJECTIVE FUNCTION | 164. | AVERAGE PERCENT ABSOLUTE ERROR | 38.03 |

UNIT HYDROGRAPH
67 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 825. | 2212. | 2666. | 2459. | 2268. | 2092. | 1930. | 1780. | 1641. | 1514. |
| 1396. | 1288. | 1188. | 1096. | 1011. | 932. | 860. | 793. | 731. | 674. |
| 622. | 574. | 529. | 488. | 450. | 415. | 383. | 353. | 326. | 300. |
| 277. | 256. | 236. | 217. | 201. | 185. | 171. | 157. | 145. | 134. |
| 123. | 114. | 105. | 97. | 89. | 82. | 76. | 70. | 65. | 60. |
| 55. | 51. | 47. | 43. | 40. | 37. | 34. | 31. | 29. | 27. |
| 25. | 23. | 21. | 19. | 18. | 16. | 15. | | | |

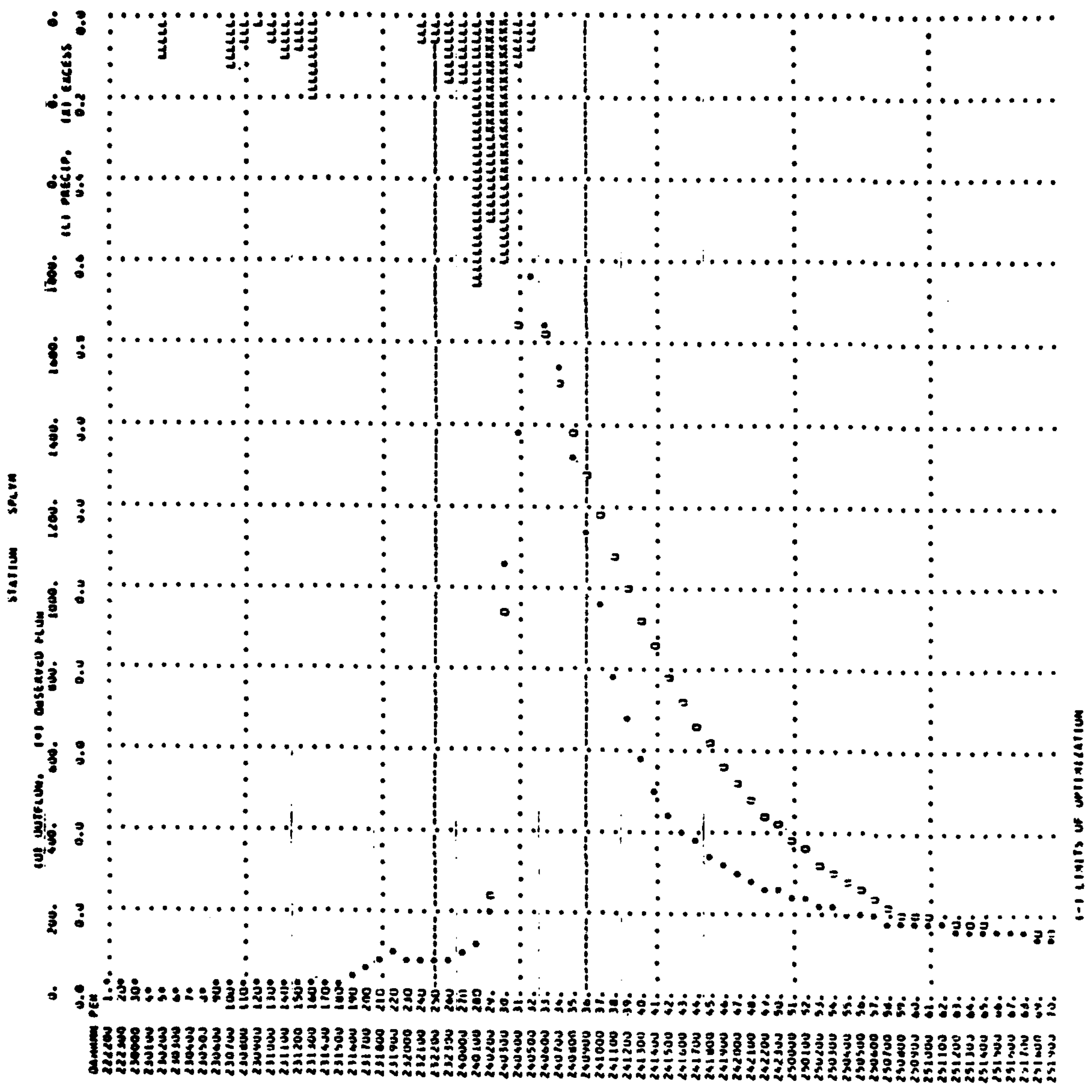
HYDROGRAPH AT STATION SPLYM

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22 JUN 2200 | 1 | 0.00 | 0.00 | 0.00 | 10. | 10. | 24 JUN 0900 | 36 | 0.01 | 0.01 | 0.00 | 1274. | 1144. |
| 22 JUN 2300 | 2 | 0.01 | 0.01 | 0.00 | 10. | 10. | 24 JUN 1000 | 37 | 0.00 | 0.00 | 0.00 | 1175. | 950. |
| 23 JUN 0000 | 3 | 0.01 | 0.01 | 0.00 | 10. | 10. | 24 JUN 1100 | 38 | 0.00 | 0.00 | 0.00 | 1084. | 782. |
| 23 JUN 0100 | 4 | 0.00 | 0.00 | 0.00 | 9. | 9. | 24 JUN 1200 | 39 | 0.01 | 0.01 | 0.00 | 1000. | 674. |
| 23 JUN 0200 | 5 | 0.10 | 0.10 | 0.00 | 9. | 9. | 24 JUN 1300 | 40 | 0.01 | 0.01 | 0.00 | 923. | 572. |
| 23 JUN 0300 | 6 | 0.00 | 0.00 | 0.00 | 9. | 9. | 24 JUN 1400 | 41 | 0.01 | 0.01 | 0.00 | 851. | 505. |
| 23 JUN 0400 | 7 | 0.00 | 0.00 | 0.00 | 9. | 9. | 24 JUN 1500 | 42 | 0.00 | 0.00 | 0.00 | 785. | 446. |
| 23 JUN 0500 | 8 | 0.00 | 0.00 | 0.00 | 8. | 9. | 24 JUN 1600 | 43 | 0.00 | 0.00 | 0.00 | 724. | 404. |
| 23 JUN 0600 | 9 | 0.01 | 0.01 | 0.00 | 8. | 10. | 24 JUN 1700 | 44 | 0.00 | 0.00 | 0.00 | 668. | 382. |
| 23 JUN 0700 | 10 | 0.13 | 0.13 | 0.00 | 8. | 11. | 24 JUN 1800 | 45 | 0.00 | 0.00 | 0.00 | 617. | 345. |
| 23 JUN 0800 | 11 | 0.06 | 0.06 | 0.00 | 8. | 11. | 24 JUN 1900 | 46 | 0.00 | 0.00 | 0.00 | 569. | 320. |
| 23 JUN 0900 | 12 | 0.02 | 0.02 | 0.00 | 8. | 11. | 24 JUN 2000 | 47 | 0.00 | 0.00 | 0.00 | 525. | 300. |
| 23 JUN 1000 | 13 | 0.07 | 0.07 | 0.00 | 8. | 12. | 24 JUN 2100 | 48 | 0.00 | 0.00 | 0.00 | 484. | 280. |
| 23 JUN 1100 | 14 | 0.11 | 0.11 | 0.00 | 7. | 13. | 24 JUN 2200 | 49 | 0.00 | 0.00 | 0.00 | 447. | 265. |
| 23 JUN 1200 | 15 | 0.09 | 0.09 | 0.00 | 7. | 15. | 24 JUN 2300 | 50 | 0.00 | 0.00 | 0.00 | 412. | 251. |
| 23 JUN 1300 | 16 | 0.20 | 0.20 | 0.00 | 7. | 18. | 25 JUN 0000 | 51 | 0.00 | 0.00 | 0.00 | 381. | 238. |
| 23 JUN 1400 | 17 | 0.01 | 0.01 | 0.00 | 7. | 21. | 25 JUN 0100 | 52 | 0.00 | 0.00 | 0.00 | 351. | 230. |
| 23 JUN 1500 | 18 | 0.00 | 0.00 | 0.00 | 7. | 26. | 25 JUN 0200 | 53 | 0.00 | 0.00 | 0.00 | 324. | 221. |
| 23 JUN 1600 | 19 | 0.00 | 0.00 | 0.00 | 7. | 43. | 25 JUN 0300 | 54 | 0.00 | 0.00 | 0.00 | 299. | 213. |
| 23 JUN 1700 | 20 | 0.00 | 0.00 | 0.00 | 6. | 67. | 25 JUN 0400 | 55 | 0.00 | 0.00 | 0.00 | 276. | 206. |
| 23 JUN 1800 | 21 | 0.00 | 0.00 | 0.00 | 6. | 79. | 25 JUN 0500 | 56 | 0.00 | 0.00 | 0.00 | 255. | 199. |
| 23 JUN 1900 | 22 | 0.00 | 0.00 | 0.00 | 6. | 92. | 25 JUN 0600 | 57 | 0.00 | 0.00 | 0.00 | 235. | 191. |
| 23 JUN 2000 | 23 | 0.00 | 0.00 | 0.00 | 6. | 88. | 25 JUN 0700 | 58 | 0.00 | 0.00 | 0.00 | 217. | 188. |
| 23 JUN 2100 | 24 | 0.06 | 0.06 | 0.00 | 6. | 83. | 25 JUN 0800 | 59 | 0.00 | 0.00 | 0.00 | 200. | 184. |
| 23 JUN 2200 | 25 | 0.06 | 0.06 | 0.00 | 6. | 79. | 25 JUN 0900 | 60 | 0.00 | 0.00 | 0.00 | 195. | 181. |
| 23 JUN 2300 | 26 | 0.17 | 0.17 | 0.00 | 6. | 74. | 25 JUN 1000 | 61 | 0.00 | 0.00 | 0.00 | 191. | 174. |
| 24 JUN 0000 | 27 | 0.17 | 0.17 | 0.00 | 5. | 97. | 25 JUN 1100 | 62 | 0.00 | 0.00 | 0.00 | 186. | 171. |
| 24 JUN 0100 | 28 | 0.67 | 0.67 | 0.00 | 5. | 126. | 25 JUN 1200 | 63 | 0.00 | 0.00 | 0.00 | 182. | 167. |
| 24 JUN 0200 | 29 | 0.50 | 0.22 | 0.28 | 232. | 193. | 25 JUN 1300 | 64 | 0.00 | 0.00 | 0.00 | 178. | 164. |
| 24 JUN 0300 | 30 | 0.60 | 0.20 | 0.40 | 947. | 1060. | 25 JUN 1400 | 65 | 0.00 | 0.00 | 0.00 | 174. | 161. |
| 24 JUN 0400 | 31 | 0.12 | 0.12 | 0.00 | 1632. | 1380. | 25 JUN 1500 | 66 | 0.00 | 0.00 | 0.00 | 169. | 158. |
| 24 JUN 0500 | 32 | 0.08 | 0.08 | 0.00 | 1759. | 1760. | 25 JUN 1600 | 67 | 0.00 | 0.00 | 0.00 | 165. | 155. |
| 24 JUN 0600 | 33 | 0.01 | 0.01 | 0.00 | 1622. | 1648. | 25 JUN 1700 | 68 | 0.00 | 0.00 | 0.00 | 162. | 152. |
| 24 JUN 0700 | 34 | 0.00 | 0.00 | 0.00 | 1497. | 1536. | 25 JUN 1800 | 69 | 0.00 | 0.00 | 0.00 | 158. | 146. |
| 24 JUN 0800 | 35 | 0.00 | 0.00 | 0.00 | 1381. | 1324. | 25 JUN 1900 | 70 | 0.00 | 0.00 | 0.00 | 154. | 143. |

TOTAL RAINFALL = 3.30, TOTAL LOSS = 2.62, TOTAL EXCESS = 0.68

| PEAK FLOW (CFS) | TIME (HR) | | 6-HR | 24-HR | 72-HR | 69.00-HR |
|---|---|---|---|---|---|---|
| | | | MAXIMUM AVERAGE FLOW | | | |
| 1759. | 31.00 | (CFS) | 1500. | 891. | 365. | 365. |
| | | (INCHES) | 0.241 | 0.572 | 0.674 | 0.674 |
| | | (AC-FT) | 744. | 1768. | 2081. | 2081. |

CUMULATIVE AREA = [illegible]



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                                                  HEC-1 INPUT                                                       PAGE  1

LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1            ID       CANASAWACTA CREEK    7-31-71
  2            ID       UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3            IT      60 29JUL71    0900      80
  4            IO       1       2
  5            OU      40      54
  6            PG    PLYM
  7            PI     .01     .52     .05     .05     .12     .06     .01     .01     .01     .01
  8            PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
  9            PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 10            PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .08
 11            PI     .13     .59     .48     .12     .01     .00     .00     .02     .00     .00

 12            KK   SPLYM
 13            QO       9       9      10      12      21      33     186     516     418     335
 14            QO     266     198     173     149     137     122     112     102      94      85
 15            QO      81      74      70      66      62      60      56      54      51      49
 16            QO      48      46      42      41      39      38      36      35      35      33
 17            QO      33      35      60      92     376    1000    1162    1345    1075     850
 18            QO     723     612     516     430     370     320     284     262     239     218
 19            QO     202     190     180     169     162     155     149     143     137     134
 20            QO     131     128     122     120     117     115     109     107     104     102
 21            PT    PLYM
 22            PW    1.00
 23            PR    PLYM
 24            PW    1.00
 25            BA    57.9      0.
 26            BF      9.    145.   1.024
 27            UC     -4.    -10.
 28            LU     -1.     -1.
 29            ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 40 THROUGH 54)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.313 | | 44.00 | | | |
| COMPUTED HYDROGRAPH | 8331. | 0.223 | 555. | 49.04 | 5.04 | 1179. | 46.00 |
| OBSERVED HYDROGRAPH | 8342. | 0.223 | 556. | 48.83 | 4.83 | 1345. | 47.00 |
| DIFFERENCE | -11. | -0.000 | -1. | 0.21 | 0.21 | -166. | -1.00 |
| PERCENT DIFFERENCE | -0.14 | | | | 4.35 | -12.37 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 74. | AVERAGE ABSOLUTE ERROR | 62. |
| OBJECTIVE FUNCTION | 83. | AVERAGE PERCENT ABSOLUTE ERROR | 34.78 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 80)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.313 | | 44.00 | | | |
| COMPUTED HYDROGRAPH | 13018. | 0.348 | 163. | 53.63 | 9.63 | 1179. | 46.00 |
| OBSERVED HYDROGRAPH | 16781. | 0.449 | 210. | 45.20 | 1.20 | 1345. | 47.00 |
| DIFFERENCE | -3763. | -0.101 | -47. | 8.43 | 8.43 | -166. | -1.00 |
| PERCENT DIFFERENCE | -22.42 | | | | 700.18 | -12.37 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 35. | AVERAGE ABSOLUTE ERROR | 18. |
| OBJECTIVE FUNCTION | 61. | AVERAGE PERCENT ABSOLUTE ERROR | 18.90 |

UNIT HYDROGRAPH
41 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 423. | 1563. | 2915. | 3759. | 3715. | 3236. | 2817. | 2452. | 2135. | 1858. |
| 1618. | 1408. | 1226. | 1067. | 929. | 809. | 704. | 613. | 533. | 464. |
| 404. | 352. | 306. | 267. | 232. | 202. | 176. | 153. | 133. | 116. |
| 101. | 88. | 77. | 67. | 58. | 50. | 44. | 38. | 33. | 29. |
| 25. | | | | | | | | | |

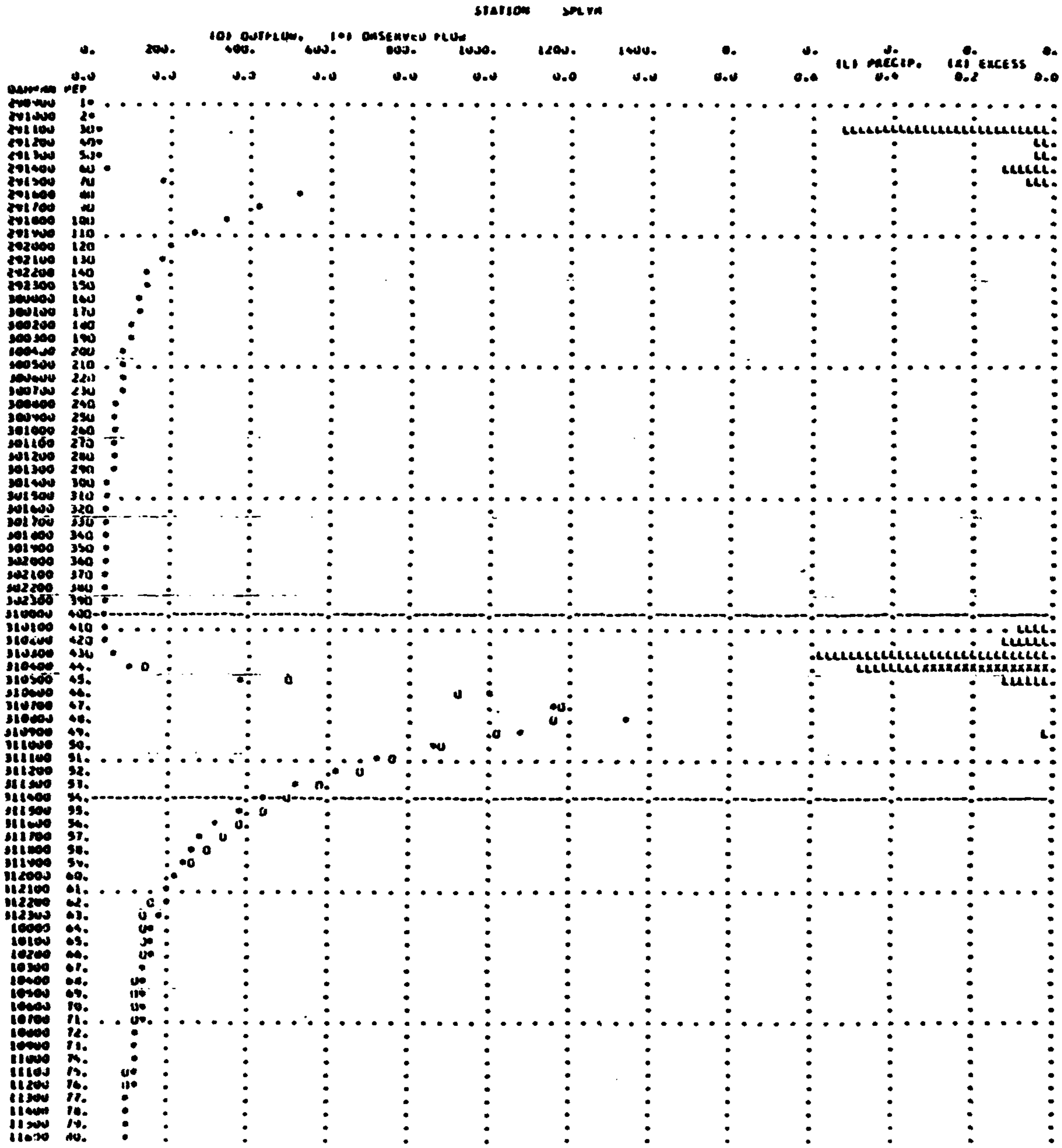
HYDROGRAPH AT STATION SPLYM

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 JUL 0900 | 1 | 0.00 | 0.00 | 0.00 | 9. | 9. | 31 JUL 0100 | 41 | 0.08 | 0.08 | 0.00 | 3. | 33. |
| 29 JUL 1000 | 2 | 0.01 | 0.01 | 0.00 | 9. | 9. | 31 JUL 0200 | 42 | 0.13 | 0.13 | 0.00 | 3. | 35. |
| 29 JUL 1100 | 3 | 0.52 | 0.52 | 0.00 | 9. | 10. | 31 JUL 0300 | 43 | 0.59 | 0.59 | 0.00 | 3. | 60. |
| 29 JUL 1200 | 4 | 0.05 | 0.05 | 0.00 | 8. | 12. | 31 JUL 0400 | 44 | 0.48 | 0.17 | 0.31 | 135. | 92. |
| 29 JUL 1300 | 5 | 0.05 | 0.05 | 0.00 | 8. | 21. | 31 JUL 0500 | 45 | 0.12 | 0.12 | 0.00 | 492. | 376. |
| 29 JUL 1400 | 6 | 0.12 | 0.12 | 0.00 | 8. | 33. | 31 JUL 0600 | 46 | 0.01 | 0.01 | 0.00 | 915. | 1000. |
| 29 JUL 1500 | 7 | 0.06 | 0.06 | 0.00 | 8. | 186. | 31 JUL 0700 | 47 | 0.00 | 0.00 | 0.00 | 1179. | 1162. |
| 29 JUL 1600 | 8 | 0.01 | 0.01 | 0.00 | 8. | 516. | 31 JUL 0800 | 48 | 0.00 | 0.00 | 0.00 | 1165. | 1345. |
| 29 JUL 1700 | 9 | 0.02 | 0.02 | 0.00 | 7. | 418. | 31 JUL 0900 | 49 | 0.02 | 0.02 | 0.00 | 1015. | 1075. |
| 29 JUL 1800 | 10 | 0.01 | 0.01 | 0.00 | 7. | 335. | 31 JUL 1000 | 50 | 0.00 | 0.00 | 0.00 | 884. | 850. |
| 29 JUL 1900 | 11 | 0.01 | 0.01 | 0.00 | 7. | 266. | 31 JUL 1100 | 51 | 0.00 | 0.00 | 0.00 | 770. | 723. |
| 29 JUL 2000 | 12 | 0.00 | 0.00 | 0.00 | 7. | 198. | 31 JUL 1200 | 52 | 0.00 | 0.00 | 0.00 | 670. | 612. |
| 29 JUL 2100 | 13 | 0.00 | 0.00 | 0.00 | 7. | 173. | 31 JUL 1300 | 53 | 0.00 | 0.00 | 0.00 | 584. | 516. |
| 29 JUL 2200 | 14 | 0.00 | 0.00 | 0.00 | 7. | 149. | 31 JUL 1400 | 54 | 0.00 | 0.00 | 0.00 | 509. | 430. |
| 29 JUL 2300 | 15 | 0.00 | 0.00 | 0.00 | 6. | 137. | 31 JUL 1500 | 55 | 0.00 | 0.00 | 0.00 | 443. | 370. |
| 30 JUL 0000 | 16 | 0.00 | 0.00 | 0.00 | 6. | 122. | 31 JUL 1600 | 56 | 0.00 | 0.00 | 0.00 | 386. | 320. |
| 30 JUL 0100 | 17 | 0.00 | 0.00 | 0.00 | 6. | 112. | 31 JUL 1700 | 57 | 0.00 | 0.00 | 0.00 | 336. | 284. |
| 30 JUL 0200 | 18 | 0.00 | 0.00 | 0.00 | 6. | 102. | 31 JUL 1800 | 58 | 0.00 | 0.00 | 0.00 | 293. | 262. |
| 30 JUL 0300 | 19 | 0.00 | 0.00 | 0.00 | 6. | 94. | 31 JUL 1900 | 59 | 0.00 | 0.00 | 0.00 | 255. | 239. |
| 30 JUL 0400 | 20 | 0.00 | 0.00 | 0.00 | 6. | 85. | 31 JUL 2000 | 60 | 0.00 | 0.00 | 0.00 | 222. | 218. |
| 30 JUL 0500 | 21 | 0.00 | 0.00 | 0.00 | 6. | 81. | 31 JUL 2100 | 61 | 0.00 | 0.00 | 0.00 | 194. | 202. |
| 30 JUL 0600 | 22 | 0.00 | 0.00 | 0.00 | 5. | 74. | 31 JUL 2200 | 62 | 0.00 | 0.00 | 0.00 | 169. | 190. |
| 30 JUL 0700 | 23 | 0.00 | 0.00 | 0.00 | 5. | 70. | 31 JUL 2300 | 63 | 0.00 | 0.00 | 0.00 | 147. | 180. |
| 30 JUL 0800 | 24 | 0.00 | 0.00 | 0.00 | 5. | 66. | 1 AUG 0000 | 64 | 0.00 | 0.00 | 0.00 | 142. | 169. |
| 30 JUL 0900 | 25 | 0.00 | 0.00 | 0.00 | 5. | 62. | 1 AUG 0100 | 65 | 0.00 | 0.00 | 0.00 | 139. | 162. |
| 30 JUL 1000 | 26 | 0.00 | 0.00 | 0.00 | 5. | 60. | 1 AUG 0200 | 66 | 0.00 | 0.00 | 0.00 | 135. | 155. |
| 30 JUL 1100 | 27 | 0.00 | 0.00 | 0.00 | 5. | 56. | 1 AUG 0300 | 67 | 0.00 | 0.00 | 0.00 | 132. | 149. |
| 30 JUL 1200 | 28 | 0.00 | 0.00 | 0.00 | 5. | 54. | 1 AUG 0400 | 68 | 0.00 | 0.00 | 0.00 | 129. | 143. |
| 30 JUL 1300 | 29 | 0.00 | 0.00 | 0.00 | 5. | 51. | 1 AUG 0500 | 69 | 0.00 | 0.00 | 0.00 | 126. | 137. |
| 30 JUL 1400 | 30 | 0.00 | 0.00 | 0.00 | 5. | 49. | 1 AUG 0600 | 70 | 0.00 | 0.00 | 0.00 | 123. | 134. |
| 30 JUL 1500 | 31 | 0.00 | 0.00 | 0.00 | 4. | 48. | 1 AUG 0700 | 71 | 0.00 | 0.00 | 0.00 | 120. | 131. |
| 30 JUL 1600 | 32 | 0.00 | 0.00 | 0.00 | 4. | 46. | 1 AUG 0800 | 72 | 0.00 | 0.00 | 0.00 | 117. | 128. |
| 30 JUL 1700 | 33 | 0.00 | 0.00 | 0.00 | 4. | 42. | 1 AUG 0900 | 73 | 0.00 | 0.00 | 0.00 | 115. | 122. |
| 30 JUL 1800 | 34 | 0.00 | 0.00 | 0.00 | 4. | 41. | 1 AUG 1000 | 74 | 0.00 | 0.00 | 0.00 | 112. | 120. |
| 30 JUL 1900 | 35 | 0.00 | 0.00 | 0.00 | 4. | 39. | 1 AUG 1100 | 75 | 0.00 | 0.00 | 0.00 | 109. | 117. |
| 30 JUL 2000 | 36 | 0.00 | 0.00 | 0.00 | 4. | 38. | 1 AUG 1200 | 76 | 0.00 | 0.00 | 0.00 | 107. | 115. |
| 30 JUL 2100 | 37 | 0.00 | 0.00 | 0.00 | 4. | 36. | 1 AUG 1300 | 77 | 0.00 | 0.00 | 0.00 | 104. | 109. |
| 30 JUL 2200 | 38 | 0.00 | 0.00 | 0.00 | 4. | 35. | 1 AUG 1400 | 78 | 0.00 | 0.00 | 0.00 | 102. | 107. |
| 30 JUL 2300 | 39 | 0.00 | 0.00 | 0.00 | 4. | 35. | 1 AUG 1500 | 79 | 0.00 | 0.00 | 0.00 | 100. | 104. |
| 31 JUL 0000 | 40 | 0.00 | 0.00 | 0.00 | 4. | 33. | 1 AUG 1600 | 80 | 0.00 | 0.00 | 0.00 | 97. | 102. |

TOTAL RAINFALL = 2.28, TOTAL LOSS = 1.97, TOTAL EXCESS = 0.31

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 79.00-HR |
|---|---|---|---|---|---|---|
| 1179. | 46.00 | (CFS) | 967. | 471. | 179. | 166. |
| | | (INCHES) | 0.155 | 0.301 | 0.345 | 0.347 |
| | | (AC-FT) | 480. | 935. | 1067. | 1072. |

CUMULATIVE AREA = 57.90 SQ MI


STATION
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1       ID        CANASAWACTA CREEK    6-22/23-72
  2       ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3       IT      60 21JUN72    1200      85
  4       IO       1       2
  5       OU       7      45
  6       PG    PLYM
  7       PI     .05  [illegible]   .01     .00     .00     .00     .01     .60     .68     .44
  8       PI     .31     .07     .18     .10     .08     .31     .24     .01     .01     .00
  9       PI     .00     .00     .00     .00     .00     .02     .01     .03     .07     .01
 10       PI     .15     .17     .23     .23     .03     .02     .01     .00     .00     .00
 11       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 12       PI     .04     .15     .06     .02     .03     .02     .00     .00     .00     .00

 13       KK   SPLYM
 14       QO      68      70      72      74      78      83      87     102     117     370
 15       QO     880    1940    3800    5000    4760    4610    4430    4550    4670    4340
 16       QO    4010    3560    3080    2675    2320    2080    1820    1620    1465    1390
 17       QO    1315    1360    1405    1780    2200    2800    3530    3680    3590    3320
 18       QO    3020    2700    2400    2180    1960    1760    1495    1375    1263    1188
 19       QO    1113    1063    1010    1030    1063    1125    1188    1175    1162    1113
 20       QO    1050    1030     970     920     880     840     810     780     750     723
 21       QO     705     678     660     636     620     604     588     564     548     524
 22       QO     508     493     486     472     465       0       0       0       0       0
 23       PT    PLYM
 24       PW    1.00
 25       PR    PLYM
 26       PW    1.00
 27       BA    57.9      0.
 28       BF     68.    810.   1.024
 29       UC     -3.     -8.
 30       LU     -.4    -.01
 31       ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 7 THROUGH 45)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.192 | | 22.05 | | | |
| COMPUTED HYDROGRAPH | 100915. | 2.701 | 2588. | 25.75 | 3.70 | 4971. | 19.00 |
| OBSERVED HYDROGRAPH | 100916. | 2.701 | 2588. | 26.37 | 4.32 | 5000. | 13.00 |
| DIFFERENCE | -1. | -0.000 | -0. | -0.62 | -0.62 | -29. | 6.00 |
| PERCENT DIFFERENCE | -0.00 | | | | -14.37 | -0.58 | |

STANDARD ERROR 448. AVERAGE ABSOLUTE ERROR 389.
OBJECTIVE FUNCTION 471. AVERAGE PERCENT ABSOLUTE ERROR 18.99

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 85)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.192 | | 22.05 | | | |
| COMPUTED HYDROGRAPH | 130672. | 3.497 | 1537. | 34.00 | 11.95 | 4971. | 19.00 |
| OBSERVED HYDROGRAPH | 136788. | 3.661 | 1609. | 35.44 | 13.39 | 5000. | 13.00 |
| DIFFERENCE | -6116. | -0.164 | -72. | -1.44 | -1.44 | -29. | 6.00 |
| PERCENT DIFFERENCE | -4.47 | | | | -10.74 | -0.58 | |

STANDARD ERROR 336. AVERAGE ABSOLUTE ERROR 250.
OBJECTIVE FUNCTION 427. AVERAGE PERCENT ABSOLUTE ERROR 16.70

UNIT HYDROGRAPH
44 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 515. | 1876. | 3233. | 3659. | 3324. | 2930. | 2563. | 2277. | 2007. | 1770. |
| 1560. | 1375. | 1212. | 1069. | 942. | 831. | 732. | 645. | 569. | 502. |
| 442. | 390. | 344. | 303. | 267. | 235. | 208. | 183. | 161. | 142. |
| 125. | 110. | 97. | 86. | 76. | 67. | 59. | 52. | 46. | 40. |
| 36. | 31. | 28. | 24. | | | | | | |

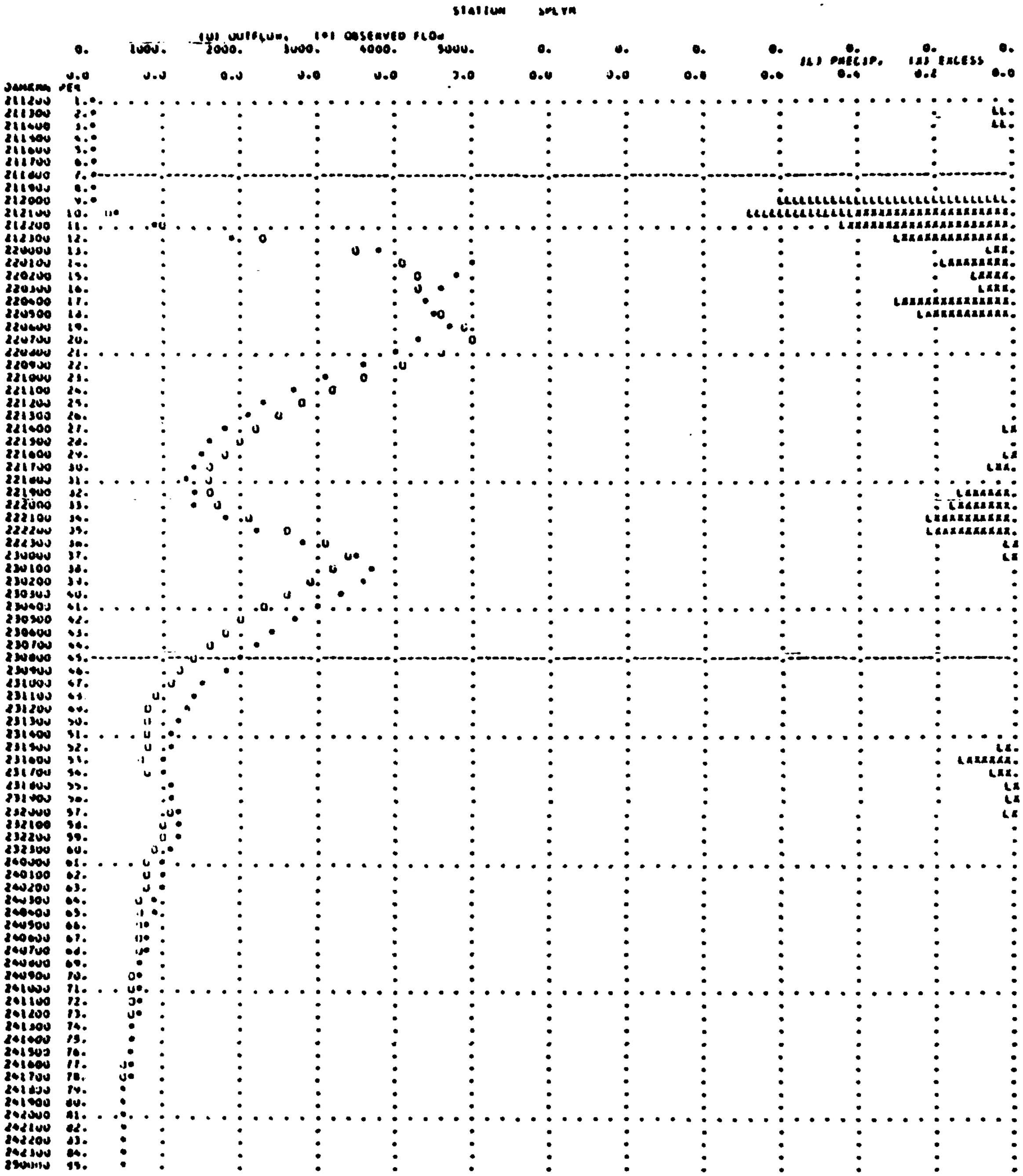
HYDROGRAPH AT STATION SPLYR

| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | JUN | 1200 | 1 | 0.00 | 0.00 | 0.00 | 68. | 68. | 23 | JUN | 0700 | 44 | 0.00 | 0.00 | 0.00 | 1553. | 2180. |
| 21 | JUN | 1300 | 2 | 0.05 | 0.05 | 0.00 | 66. | 70. | 23 | JUN | 0800 | 45 | 0.00 | 0.00 | 0.00 | 1371. | 1960. |
| 21 | JUN | 1400 | 3 | 0.05 | 0.05 | 0.00 | 65. | 72. | 23 | JUN | 0900 | 46 | 0.00 | 0.00 | 0.00 | 1211. | 1760. |
| 21 | JUN | 1500 | 4 | 0.01 | 0.01 | 0.00 | 63. | 74. | 23 | JUN | 1000 | 47 | 0.00 | 0.00 | 0.00 | 1070. | 1495. |
| 21 | JUN | 1600 | 5 | 0.00 | 0.00 | 0.00 | 62. | 78. | 23 | JUN | 1100 | 48 | 0.00 | 0.00 | 0.00 | 945. | 1375. |
| 21 | JUN | 1700 | 6 | 0.00 | 0.00 | 0.00 | 60. | 83. | 23 | JUN | 1200 | 49 | 0.00 | 0.00 | 0.00 | 835. | 1263. |
| 21 | JUN | 1800 | 7 | 0.00 | 0.00 | 0.00 | 59. | 87. | 23 | JUN | 1300 | 50 | 0.00 | 0.00 | 0.00 | 746. | 1188. |
| 21 | JUN | 1900 | 8 | 0.01 | 0.01 | 0.00 | 58. | 102. | 23 | JUN | 1400 | 51 | 0.00 | 0.00 | 0.00 | 777. | 1113. |
| 21 | JUN | 2000 | 9 | 0.60 | 0.60 | 0.00 | 56. | 117. | 23 | JUN | 1500 | 52 | 0.04 | 0.01 | 0.03 | 759. | 1063. |
| 21 | JUN | 2100 | 10 | 0.68 | 0.28 | 0.40 | 263. | 370. | 23 | JUN | 1600 | 53 | 0.15 | 0.01 | 0.14 | 741. | 1010. |
| 21 | JUN | 2200 | 11 | 0.44 | 0.01 | 0.43 | 1033. | 880. | 23 | JUN | 1700 | 54 | 0.06 | 0.01 | 0.05 | 833. | 1030. |
| 21 | JUN | 2300 | 12 | 0.31 | 0.01 | 0.30 | 2330. | 1940. | 23 | JUN | 1800 | 55 | 0.02 | 0.01 | 0.01 | 1054. | 1063. |
| 22 | JUN | 0000 | 13 | 0.37 | 0.01 | 0.36 | 3527. | 3800. | 23 | JUN | 1900 | 56 | 0.03 | 0.01 | 0.02 | 1146. | 1125. |
| 22 | JUN | 0100 | 14 | 0.18 | 0.01 | 0.17 | 4149. | 5000. | 23 | JUN | 2000 | 57 | 0.02 | 0.01 | 0.01 | 1116. | 1188. |
| 22 | JUN | 0200 | 15 | 0.10 | 0.01 | 0.09 | 4329. | 4760. | 23 | JUN | 2100 | 58 | 0.00 | 0.00 | 0.00 | 1044. | 1175. |
| 22 | JUN | 0300 | 16 | 0.08 | 0.01 | 0.07 | 4337. | 4610. | 23 | JUN | 2200 | 59 | 0.00 | 0.00 | 0.00 | 954. | 1162. |
| 22 | JUN | 0400 | 17 | 0.31 | 0.01 | 0.30 | 4369. | 4430. | 23 | JUN | 2300 | 60 | 0.00 | 0.00 | 0.00 | 852. | 1113. |
| 22 | JUN | 0500 | 18 | 0.24 | 0.01 | 0.23 | 4603. | 4550. | 24 | JUN | 0000 | 61 | 0.00 | 0.00 | 0.00 | 799. | 1050. |
| 22 | JUN | 0600 | 19 | 0.01 | 0.01 | 0.00 | 4937. | 4670. | 24 | JUN | 0100 | 62 | 0.00 | 0.00 | 0.00 | 780. | 1030. |
| 22 | JUN | 0700 | 20 | 0.01 | 0.01 | 0.00 | 4971. | 4340. | 24 | JUN | 0200 | 63 | 0.00 | 0.00 | 0.00 | 762. | 970. |
| 22 | JUN | 0800 | 21 | 0.00 | 0.00 | 0.00 | 4600. | 4010. | 24 | JUN | 0300 | 64 | 0.00 | 0.00 | 0.00 | 744. | 920. |
| 22 | JUN | 0900 | 22 | 0.00 | 0.00 | 0.00 | 4084. | 3560. | 24 | JUN | 0400 | 65 | 0.00 | 0.00 | 0.00 | 726. | 880. |
| 22 | JUN | 1000 | 23 | 0.00 | 0.00 | 0.00 | 3634. | 3080. | 24 | JUN | 0500 | 66 | 0.00 | 0.00 | 0.00 | 709. | 840. |
| 22 | JUN | 1100 | 24 | 0.00 | 0.00 | 0.00 | 3181. | 2675. | 24 | JUN | 0600 | 67 | 0.00 | 0.00 | 0.00 | 693. | 810. |
| 22 | JUN | 1200 | 25 | 0.00 | 0.00 | 0.00 | 2808. | 2320. | 24 | JUN | 0700 | 68 | 0.00 | 0.00 | 0.00 | 676. | 780. |
| 22 | JUN | 1300 | 26 | 0.00 | 0.00 | 0.00 | 2479. | 2080. | 24 | JUN | 0800 | 69 | 0.00 | 0.00 | 0.00 | 661. | 750. |
| 22 | JUN | 1400 | 27 | 0.02 | 0.01 | 0.01 | 2195. | 1820. | 24 | JUN | 0900 | 70 | 0.00 | 0.00 | 0.00 | 645. | 723. |
| 22 | JUN | 1500 | 28 | 0.01 | 0.01 | 0.00 | 1954. | 1620. | 24 | JUN | 1000 | 71 | 0.00 | 0.00 | 0.00 | 630. | 705. |
| 22 | JUN | 1600 | 29 | 0.03 | 0.01 | 0.02 | 1754. | 1465. | 24 | JUN | 1100 | 72 | 0.00 | 0.00 | 0.00 | 615. | 678. |
| 22 | JUN | 1700 | 30 | 0.37 | 0.01 | 0.36 | 1620. | 1390. | 24 | JUN | 1200 | 73 | 0.00 | 0.00 | 0.00 | 601. | 660. |
| 22 | JUN | 1800 | 31 | 0.01 | 0.01 | 0.00 | 1552. | 1315. | 24 | JUN | 1300 | 74 | 0.00 | 0.00 | 0.00 | 587. | 636. |
| 22 | JUN | 1900 | 32 | 0.15 | 0.01 | 0.14 | 1558. | 1360. | 24 | JUN | 1400 | 75 | 0.00 | 0.00 | 0.00 | 573. | 620. |
| 22 | JUN | 2000 | 33 | 0.17 | 0.01 | 0.16 | 1711. | 1405. | 24 | JUN | 1500 | 76 | 0.00 | 0.00 | 0.00 | 560. | 604. |
| 22 | JUN | 2100 | 34 | 0.23 | 0.01 | 0.22 | 2084. | 1780. | 24 | JUN | 1600 | 77 | 0.00 | 0.00 | 0.00 | 546. | 588. |
| 22 | JUN | 2200 | 35 | 0.23 | 0.01 | 0.22 | 2636. | 2200. | 24 | JUN | 1700 | 78 | 0.00 | 0.00 | 0.00 | 534. | 564. |
| 22 | JUN | 2300 | 36 | 0.03 | 0.01 | 0.02 | 3145. | 2800. | 24 | JUN | 1800 | 79 | 0.00 | 0.00 | 0.00 | 521. | 548. |
| 23 | JUN | 0000 | 37 | 0.02 | 0.01 | 0.01 | 3354. | 3530. | 24 | JUN | 1900 | 80 | 0.00 | 0.00 | 0.00 | 509. | 524. |
| 23 | JUN | 0100 | 38 | 0.01 | 0.01 | 0.00 | 3204. | 3680. | 24 | JUN | 2000 | 81 | 0.00 | 0.00 | 0.00 | 497. | 508. |
| 23 | JUN | 0200 | 39 | 0.00 | 0.00 | 0.00 | 2883. | 3590. | 24 | JUN | 2100 | 82 | 0.00 | 0.00 | 0.00 | 485. | 493. |
| 23 | JUN | 0300 | 40 | 0.00 | 0.00 | 0.00 | 2556. | 3320. | 24 | JUN | 2200 | 83 | 0.00 | 0.00 | 0.00 | 474. | 486. |
| 23 | JUN | 0400 | 41 | 0.00 | 0.00 | 0.00 | 2257. | 3020. | 24 | JUN | 2300 | 84 | 0.00 | 0.00 | 0.00 | 463. | 472. |
| 23 | JUN | 0500 | 42 | 0.00 | 0.00 | 0.00 | 1992. | 2700. | 25 | JUN | 0000 | 85 | 0.00 | 0.00 | 0.00 | 452. | 465. |
| 23 | JUN | 0600 | 43 | 0.00 | 0.00 | 0.00 | 1759. | 2400. | | | | | | | | | |

TOTAL RAINFALL = 4.45, TOTAL LOSS = 1.26, TOTAL EXCESS = 3.19

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 84.00-HR |
|---|---|---|---|---|---|---|
| 4971. | 14.00 | (CFS) | 4615. | 3171. | 1763. | 1553. |
| | | (INCHES) | 0.741 | 2.037 | 3.435 | 3.490 |
| | | (AC-FT) | 2288. | 6299. | 10608. | 10778. |

CUMULATIVE AREA = 57.90 SQ MI




(-) LIMITS OF OPTIMIZATION

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                              HEC-1 INPUT                                       PAGE  1

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID        CANASAWACTA CREEK     7-03-74
  2         ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3         IT      60 03JUL74    0400      55
  4         IO       1       2
  5         OU       1      15
  6         PG    PLYM
  7         PI     .05     .44     .91     .40     .05     .10     .00     .00     .00     .00
  8         PI     .00     .01     .00     .01     .01     .01     .01     .00     .00     .00

  9         KK   SPLYM
 10         QO      30      30      33      72     223    1016    2678    3951    4095    3782
 11         JJ    2989    2484    1961    1665    1369    1141     962     850     772     707
 12         QO     654     620     587     555     533     512     489     475     455     442
 13         QO     429     416     403     385     373     355     340     330     315     301
 14         QO     292     283     278     270     265     261     257     257     252     248
 15         QO     244     239     239     235     231       0       0       0       0       0
 16         PT    PLYM
 17         PW    1.00
 18         PR    PLYM
 19         PW    1.00
 20         BA    57.9      0.
 21         HF     30.    285.   1.024
 22         UC     -5.     -5.
 23         LU     -.5   -.04
 24         ZZ
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COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 1 THROUGH 15)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.807 | | 4.51 | | | |
| COMPUTED HYDROGRAPH | 26373. | 0.706 | 1758. | 9.79 | 5.28 | 3816. | 8.00 |
| OBSERVED HYDROGRAPH | 26378. | 0.706 | 1759. | 10.04 | 5.53 | 4095. | 8.00 |
| DIFFERENCE | -5. | -0.000 | -0. | -0.25 | -0.25 | -279. | 0.00 |
| PERCENT DIFFERENCE | -0.02 | | | | -4.50 | -6.81 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 279. | AVERAGE ABSOLUTE ERROR | 186. |
| OBJECTIVE FUNCTION | 277. | AVERAGE PERCENT ABSOLUTE ERROR | 37.03 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 55)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.807 | | 4.51 | | | |
| COMPUTED HYDROGRAPH | 36280. | 0.971 | 660. | 15.32 | 10.81 | 3816. | 8.00 |
| OBSERVED HYDROGRAPH | 43630. | 1.168 | 793. | 18.09 | 13.58 | 4095. | 8.00 |
| DIFFERENCE | -7350. | -0.197 | -134. | -2.77 | -2.77 | -279. | 0.00 |
| PERCENT DIFFERENCE | -16.85 | | | | -20.39 | -6.81 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 225. | AVERAGE ABSOLUTE ERROR | 184. |
| OBJECTIVE FUNCTION | 267. | AVERAGE PERCENT ABSOLUTE ERROR | 41.75 |

UNIT HYDROGRAPH
25 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 374. | 1365. | 2655. | 3892. | 4686. | 4828. | 4235. | 3332. | 2608. | 2041. |
| 1597. | 1250. | 978. | 765. | 599. | 469. | 367. | 287. | 225. | 176. |
| 138. | 108. | 84. | 66. | 52. | | | | | |

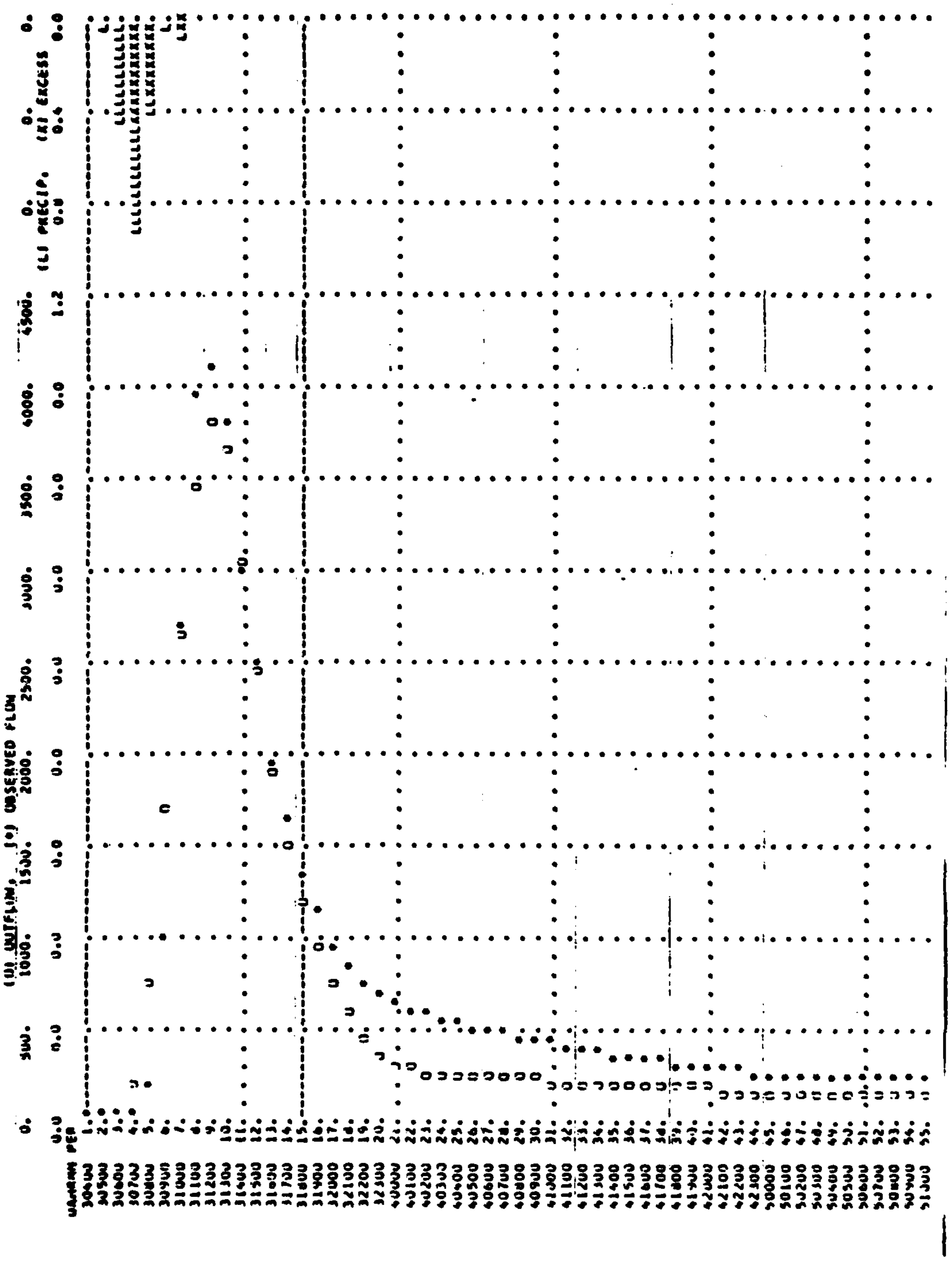
HYDROGRAPH AT STATION SPLYM

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 JUL 0400 | 1 | 0.00 | 0.00 | 0.00 | 30. | 30. | 4 JUL 0800 | 29 | 0.00 | 0.00 | 0.00 | 236. | 455. |
| 3 JUL 0500 | 2 | 0.05 | 0.05 | 0.00 | 29. | 30. | 4 JUL 0900 | 30 | 0.00 | 0.00 | 0.00 | 230. | 442. |
| 3 JUL 0600 | 3 | 0.44 | 0.44 | 0.00 | 29. | 33. | 4 JUL 1000 | 31 | 0.00 | 0.00 | 0.00 | 225. | 429. |
| 3 JUL 0700 | 4 | 0.91 | 0.46 | 0.45 | 199. | 72. | 4 JUL 1100 | 32 | 0.00 | 0.00 | 0.00 | 220. | 416. |
| 3 JUL 0800 | 5 | 0.40 | 0.07 | 0.33 | 769. | 223. | 4 JUL 1200 | 33 | 0.00 | 0.00 | 0.00 | 214. | 403. |
| 3 JUL 0900 | 6 | 0.05 | 0.05 | 0.00 | 1675. | 1010. | 4 JUL 1300 | 34 | 0.00 | 0.00 | 0.00 | 209. | 385. |
| 3 JUL 1000 | 7 | 0.10 | 0.07 | 0.03 | 2667. | 2678. | 4 JUL 1400 | 35 | 0.00 | 0.00 | 0.00 | 204. | 373. |
| 3 JUL 1100 | 8 | 0.00 | 0.00 | 0.00 | 3457. | 3951. | 4 JUL 1500 | 36 | 0.00 | 0.00 | 0.00 | 200. | 355. |
| 3 JUL 1200 | 9 | 0.00 | 0.00 | 0.00 | 3816. | 4095. | 4 JUL 1600 | 37 | 0.00 | 0.00 | 0.00 | 195. | 340. |
| 3 JUL 1300 | 10 | 0.00 | 0.00 | 0.00 | 3628. | 3782. | 4 JUL 1700 | 38 | 0.00 | 0.00 | 0.00 | 190. | 330. |
| 3 JUL 1400 | 11 | 0.00 | 0.00 | 0.00 | 3046. | 2989. | 4 JUL 1800 | 39 | 0.00 | 0.00 | 0.00 | 186. | 315. |
| 3 JUL 1500 | 12 | 0.00 | 0.00 | 0.00 | 2427. | 2484. | 4 JUL 1900 | 40 | 0.00 | 0.00 | 0.00 | 182. | 301. |
| 3 JUL 1600 | 13 | 0.01 | 0.01 | 0.00 | 1916. | 1961. | 4 JUL 2000 | 41 | 0.00 | 0.00 | 0.00 | 177. | 292. |
| 3 JUL 1700 | 14 | 0.00 | 0.00 | 0.00 | 1504. | 1665. | 4 JUL 2100 | 42 | 0.00 | 0.00 | 0.00 | 173. | 283. |
| 3 JUL 1800 | 15 | 0.01 | 0.01 | 0.00 | 1181. | 1369. | 4 JUL 2200 | 43 | 0.00 | 0.00 | 0.00 | 169. | 278. |
| 3 JUL 1900 | 16 | 0.01 | 0.01 | 0.00 | 929. | 1141. | 4 JUL 2300 | 44 | 0.00 | 0.00 | 0.00 | 165. | 270. |
| 3 JUL 2000 | 17 | 0.01 | 0.01 | 0.00 | 731. | 962. | 5 JUL 0000 | 45 | 0.00 | 0.00 | 0.00 | 161. | 265. |
| 3 JUL 2100 | 18 | 0.01 | 0.01 | 0.00 | 576. | 850. | 5 JUL 0100 | 46 | 0.00 | 0.00 | 0.00 | 158. | 261. |
| 3 JUL 2200 | 19 | 0.00 | 0.00 | 0.00 | 455. | 772. | 5 JUL 0200 | 47 | 0.00 | 0.00 | 0.00 | 154. | 257. |
| 3 JUL 2300 | 20 | 0.00 | 0.00 | 0.00 | 360. | 707. | 5 JUL 0300 | 48 | 0.00 | 0.00 | 0.00 | 150. | 257. |
| 4 JUL 0000 | 21 | 0.00 | 0.00 | 0.00 | 285. | 654. | 5 JUL 0400 | 49 | 0.00 | 0.00 | 0.00 | 147. | 252. |
| 4 JUL 0100 | 22 | 0.00 | 0.00 | 0.00 | 278. | 620. | 5 JUL 0500 | 50 | 0.00 | 0.00 | 0.00 | 143. | 248. |
| 4 JUL 0200 | 23 | 0.00 | 0.00 | 0.00 | 272. | 587. | 5 JUL 0600 | 51 | 0.00 | 0.00 | 0.00 | 140. | 244. |
| 4 JUL 0300 | 24 | 0.00 | 0.00 | 0.00 | 265. | 555. | 5 JUL 0700 | 52 | 0.00 | 0.00 | 0.00 | 137. | 239. |
| 4 JUL 0400 | 25 | 0.00 | 0.00 | 0.00 | 259. | 533. | 5 JUL 0800 | 53 | 0.00 | 0.00 | 0.00 | 133. | 239. |
| 4 JUL 0500 | 26 | 0.00 | 0.00 | 0.00 | 253. | 512. | 5 JUL 0900 | 54 | 0.00 | 0.00 | 0.00 | 130. | 235. |
| 4 JUL 0600 | 27 | 0.00 | 0.00 | 0.00 | 247. | 489. | 5 JUL 1000 | 55 | 0.00 | 0.00 | 0.00 | 127. | 231. |
| 4 JUL 0700 | 28 | 0.00 | 0.00 | 0.00 | 241. | 475. | | | | | | | |

TOTAL RAINFALL = 2.00, TOTAL LOSS = 1.19, TOTAL EXCESS = 0.81

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 54.00-HR |
|---|---|---|---|---|---|---|
| 3816. | 8.00 | (CFS) | 3111. | 1301. | 670. | 670. |
| | | (INCHES) | 0.530 | 0.835 | 0.969 | 0.969 |
| | | (AC-FT) | 1543. | 2580. | 2992. | 2992. |

CUMULATIVE AREA = 57.90 SQ MI


STATION SPLYN
(O) OUTFLOW, (*) OBSERVED FLOW
0. 500. 1000. 1500. 2000. 2500. 3000. 3500. 4000. 4500. 0. 0. 0.
(L) PRECIP. (X) EXCESS
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 1.2 0.8 0.4 0.0
DAHRMN PER

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                                         HEC-1 INPUT                                              PAGE  1

 LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1           ID        CHARLOTTE CREEK 6-29-73
   2           ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
   3           IT      60 28JUN73    2000     110
   4           IO       1       2
   5           OU       7      35
   6           PG     KOR    3.21
   7           PG     OSU    4.46
   8           PG     COB    2.04
   9           PG     STM    2.73
  10           PG    ESID
  11           PI     .00     .00     .00     .00     .20     .90     .30     .20     .50     .10
  12           PI     .20     .10     .10     .00     .00     .10     .20     .30     .00     .00

  13           KK    WDAV
  14           QO     107     107     107     107     110     111     112     131     149     322
  15           QO     495    1034    1573    1811    2049    2107    2164    2201    2238    2640
  16           QO    3042    3224    3405    3515    3625    3691    3647    3565    3482    3378
  17           QO    3273    3097    2921    2726    2530    2339    2148    2042    1936    1912
  18           QO    1883    1862    1836    1757    1678    1598    1517    1435    1352    1295
  19           QO    1238    1202    1166    1136    1106    1082    1058    1034    1010     994
  20           QO     977     963     949     933     917     901     884     865     845     826
  21           QO     806     783     760     745     730     718     705     693     680     673
  22           QO     665     660     655     652     650     645     640     633     625     617
  23           QO     610     602     595     582     568     556     545     535     523     516
  24           QO     509     505     500     495     491     488     486     484     482     480
  25           PT     KOR     OSU     COB     STM
  26           PW     .60     .02     .09     .29
  27           PR    ESID
  28           PW    1.00
  29           BA    167.      0.
  30           BF    107.    500.  1.0165
  31           UC    -13.    -22.
  32           LU     -1.     -1.
  33           ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 7 THROUGH 35)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.128 | | 11.66 | | | |
| COMPUTED HYDROGRAPH | 68046. | 0.631 | 2346. | 24.76 | 13.10 | 3539. | 24.00 |
| OBSERVED HYDROGRAPH | 68147. | 0.632 | 2350. | 24.49 | 12.84 | 3691. | 25.00 |
| DIFFERENCE | -101. | -0.001 | -3. | 0.27 | 0.27 | -152. | -1.00 |
| PERCENT DIFFERENCE | -0.15 | | | | 2.07 | -4.13 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 249. | AVERAGE ABSOLUTE ERROR | 180. |
| OBJECTIVE FUNCTION | 242. | AVERAGE PERCENT ABSOLUTE ERROR | 9.78 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 110)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.128 | | 11.66 | | | |
| COMPUTED HYDROGRAPH | 130634. | 1.212 | 1188. | 40.48 | 28.83 | 3539. | 24.00 |
| OBSERVED HYDROGRAPH | 139764. | 1.297 | 1271. | 44.03 | 32.38 | 3691. | 25.00 |
| DIFFERENCE | -9130. | -0.085 | -83. | -3.55 | -3.55 | -152. | -1.00 |
| PERCENT DIFFERENCE | -6.53 | | | | -10.96 | -4.13 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 219. | AVERAGE ABSOLUTE ERROR | 183. |
| OBJECTIVE FUNCTION | 238. | AVERAGE PERCENT ABSOLUTE ERROR | 21.90 |

UNIT HYDROGRAPH
119 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 86. | 241. | 447. | 806. | 1148. | 1521. | 1918. | 2325. | 2706. | 3032. |
| 3300. | 3539. | 3652. | 3720. | 3677. | 3535. | 3370. | 3213. | 3063. | 2919. |
| 2783. | 2653. | 2529. | 2411. | 2298. | 2191. | 2088. | 1991. | 1898. | 1809. |
| 1725. | 1644. | 1567. | 1494. | 1424. | 1358. | 1294. | 1234. | 1176. | 1121. |
| 1069. | 1019. | 971. | 926. | 883. | 841. | 802. | 764. | 729. | 695. |
| 662. | 631. | 602. | 574. | 547. | 521. | 497. | 474. | 452. | 431. |
| 410. | 391. | 373. | 356. | 339. | 323. | 308. | 294. | 280. | 267. |
| 254. | 242. | 231. | 220. | 210. | 200. | 191. | 182. | 173. | 165. |
| 158. | 150. | 143. | 137. | 130. | 124. | 118. | 113. | 107. | 102. |
| 98. | 93. | 89. | 85. | 81. | 77. | 73. | 70. | 67. | 63. |
| 61. | 58. | 55. | 52. | 50. | 48. | 45. | 43. | 41. | 39. |
| 37. | 36. | 34. | 32. | 31. | 30. | 28. | 27. | 26. | |

HYDROGRAPH AT STATION MDAV

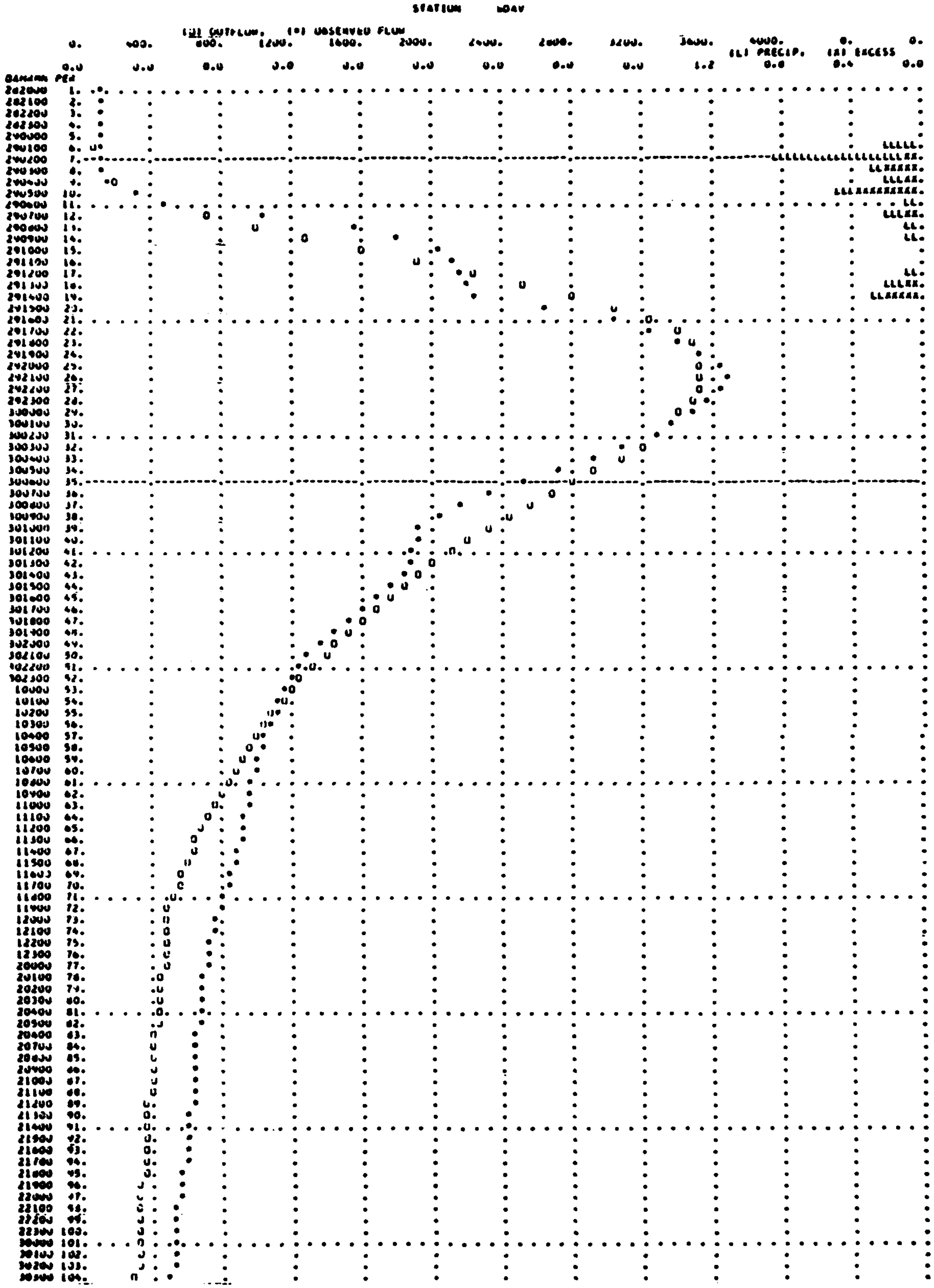
| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 28 JUN 2000 | 1 | 0.00 | 0.00 | 0.00 | 107. | 107. |
| 28 JUN 2100 | 2 | 0.00 | 0.00 | 0.00 | 105. | 107. |
| 28 JUN 2200 | 3 | 0.00 | 0.00 | 0.00 | 104. | 107. |
| 28 JUN 2300 | 4 | 0.00 | 0.00 | 0.00 | 102. | 107. |
| 29 JUN 0000 | 5 | 0.00 | 0.00 | 0.00 | 100. | 110. |
| 29 JUN 0100 | 6 | 0.19 | 0.19 | 0.00 | 99. | 111. |
| 29 JUN 0200 | 7 | 0.84 | 0.74 | 0.10 | 103. | 112. |
| 29 JUN 0300 | 8 | 0.28 | 0.09 | 0.19 | 131. | 131. |
| 29 JUN 0400 | 9 | 0.19 | 0.09 | 0.09 | 193. | 149. |
| 29 JUN 0500 | 10 | 0.47 | 0.09 | 0.37 | 310. | 322. |
| 29 JUN 0600 | 11 | 0.09 | 0.09 | 0.00 | 489. | 495. |
| 29 JUN 0700 | 12 | 0.19 | 0.09 | 0.09 | 719. | 1034. |
| 29 JUN 0800 | 13 | 0.09 | 0.09 | 0.00 | 989. | 1573. |
| 29 JUN 0900 | 14 | 0.09 | 0.09 | 0.00 | 1293. | 1811. |
| 29 JUN 1000 | 15 | 0.00 | 0.00 | 0.00 | 1607. | 2049. |
| 29 JUN 1100 | 16 | 0.00 | 0.00 | 0.00 | 1928. | 2107. |
| 29 JUN 1200 | 17 | 0.09 | 0.09 | 0.00 | 2237. | 2164. |
| 29 JUN 1300 | 18 | 0.19 | 0.09 | 0.09 | 2523. | 2201. |
| 29 JUN 1400 | 19 | 0.28 | 0.09 | 0.19 | 2789. | 2238. |
| 29 JUN 1500 | 20 | 0.00 | 0.00 | 0.00 | 3034. | 2840. |
| 29 JUN 1600 | 21 | 0.00 | 0.00 | 0.00 | 3240. | 3042. |
| 29 JUN 1700 | 22 | 0.00 | 0.00 | 0.00 | 3392. | 3224. |
| 29 JUN 1800 | 23 | 0.00 | 0.00 | 0.00 | 3489. | 3405. |
| 29 JUN 1900 | 24 | 0.00 | 0.00 | 0.00 | 3533. | 3515. |
| 29 JUN 2000 | 25 | 0.00 | 0.00 | 0.00 | 3539. | 3625. |
| 29 JUN 2100 | 26 | 0.00 | 0.00 | 0.00 | 3527. | 3691. |
| 29 JUN 2200 | 27 | 0.00 | 0.00 | 0.00 | 3501. | 3647. |
| 29 JUN 2300 | 28 | 0.00 | 0.00 | 0.00 | 3463. | 3565. |
| 30 JUN 0000 | 29 | 0.00 | 0.00 | 0.00 | 3414. | 3482. |
| 30 JUN 0100 | 30 | 0.00 | 0.00 | 0.00 | 3356. | 3378. |
| 30 JUN 0200 | 31 | 0.00 | 0.00 | 0.00 | 3279. | 3273. |
| 30 JUN 0300 | 32 | 0.00 | 0.00 | 0.00 | 3184. | 3097. |
| 30 JUN 0400 | 33 | 0.00 | 0.00 | 0.00 | 3065. | 2921. |
| 30 JUN 0500 | 34 | 0.00 | 0.00 | 0.00 | 2929. | 2726. |
| 30 JUN 0600 | 35 | 0.00 | 0.00 | 0.00 | 2794. | 2530. |
| 30 JUN 0700 | 36 | 0.00 | 0.00 | 0.00 | 2666. | 2339. |
| 30 JUN 0800 | 37 | 0.00 | 0.00 | 0.00 | 2543. | 2148. |
| 30 JUN 0900 | 38 | 0.00 | 0.00 | 0.00 | 2426. | 2042. |
| 30 JUN 1000 | 39 | 0.00 | 0.00 | 0.00 | 2314. | 1936. |
| 30 JUN 1100 | 40 | 0.00 | 0.00 | 0.00 | 2208. | 1912. |
| 30 JUN 1200 | 41 | 0.00 | 0.00 | 0.00 | 2107. | 1898. |
| 30 JUN 1300 | 42 | 0.00 | 0.00 | 0.00 | 2010. | 1862. |
| 30 JUN 1400 | 43 | 0.00 | 0.00 | 0.00 | 1918. | 1836. |
| 30 JUN 1500 | 44 | 0.00 | 0.00 | 0.00 | 1830. | 1757. |
| 30 JUN 1600 | 45 | 0.00 | 0.00 | 0.00 | 1746. | 1678. |
| 30 JUN 1700 | 46 | 0.00 | 0.00 | 0.00 | 1666. | 1598. |
| 30 JUN 1800 | 47 | 0.00 | 0.00 | 0.00 | 1589. | 1517. |
| 30 JUN 1900 | 48 | 0.00 | 0.00 | 0.00 | 1517. | 1435. |
| 30 JUN 2000 | 49 | 0.00 | 0.00 | 0.00 | 1447. | 1352. |
| 30 JUN 2100 | 50 | 0.00 | 0.00 | 0.00 | 1381. | 1295. |
| 30 JUN 2200 | 51 | 0.00 | 0.00 | 0.00 | 1318. | 1238. |
| 30 JUN 2300 | 52 | 0.00 | 0.00 | 0.00 | 1258. | 1202. |
| 1 JUL 0000 | 53 | 0.00 | 0.00 | 0.00 | 1201. | 1166. |
| 1 JUL 0100 | 54 | 0.00 | 0.00 | 0.00 | 1146. | 1136. |
| 1 JUL 0200 | 55 | 0.00 | 0.00 | 0.00 | 1094. | 1106. |

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 1 JUL 0300 | 56 | 0.00 | 0.00 | 0.00 | 1044. | 1082. |
| 1 JUL 0400 | 57 | 0.00 | 0.00 | 0.00 | 997. | 1058. |
| 1 JUL 0500 | 58 | 0.00 | 0.00 | 0.00 | 951. | 1034. |
| 1 JUL 0600 | 59 | 0.00 | 0.00 | 0.00 | 908. | 1010. |
| 1 JUL 0700 | 60 | 0.00 | 0.00 | 0.00 | 867. | 994. |
| 1 JUL 0800 | 61 | 0.00 | 0.00 | 0.00 | 828. | 977. |
| 1 JUL 0900 | 62 | 0.00 | 0.00 | 0.00 | 790. | 963. |
| 1 JUL 1000 | 63 | 0.00 | 0.00 | 0.00 | 754. | 949. |
| 1 JUL 1100 | 64 | 0.00 | 0.00 | 0.00 | 720. | 933. |
| 1 JUL 1200 | 65 | 0.00 | 0.00 | 0.00 | 688. | 917. |
| 1 JUL 1300 | 66 | 0.00 | 0.00 | 0.00 | 657. | 901. |
| 1 JUL 1400 | 67 | 0.00 | 0.00 | 0.00 | 627. | 884. |
| 1 JUL 1500 | 68 | 0.00 | 0.00 | 0.00 | 599. | 865. |
| 1 JUL 1600 | 69 | 0.00 | 0.00 | 0.00 | 572. | 845. |
| 1 JUL 1700 | 70 | 0.00 | 0.00 | 0.00 | 547. | 826. |
| 1 JUL 1800 | 71 | 0.00 | 0.00 | 0.00 | 522. | 806. |
| 1 JUL 1900 | 72 | 0.00 | 0.00 | 0.00 | 500. | 785. |
| 1 JUL 2000 | 73 | 0.00 | 0.00 | 0.00 | 491. | 760. |
| 1 JUL 2100 | 74 | 0.00 | 0.00 | 0.00 | 483. | 745. |
| 1 JUL 2200 | 75 | 0.00 | 0.00 | 0.00 | 474. | 730. |
| 1 JUL 2300 | 76 | 0.00 | 0.00 | 0.00 | 466. | 718. |
| 2 JUL 0000 | 77 | 0.00 | 0.00 | 0.00 | 460. | 705. |
| 2 JUL 0100 | 78 | 0.00 | 0.00 | 0.00 | 453. | 693. |
| 2 JUL 0200 | 79 | 0.00 | 0.00 | 0.00 | 445. | 680. |
| 2 JUL 0300 | 80 | 0.00 | 0.00 | 0.00 | 438. | 673. |
| 2 JUL 0400 | 81 | 0.00 | 0.00 | 0.00 | 431. | 665. |
| 2 JUL 0500 | 82 | 0.00 | 0.00 | 0.00 | 424. | 660. |
| 2 JUL 0600 | 83 | 0.00 | 0.00 | 0.00 | 417. | 655. |
| 2 JUL 0700 | 84 | 0.00 | 0.00 | 0.00 | 410. | 652. |
| 2 JUL 0800 | 85 | 0.00 | 0.00 | 0.00 | 404. | 650. |
| 2 JUL 0900 | 86 | 0.00 | 0.00 | 0.00 | 397. | 645. |
| 2 JUL 1000 | 87 | 0.00 | 0.00 | 0.00 | 391. | 640. |
| 2 JUL 1100 | 88 | 0.00 | 0.00 | 0.00 | 384. | 633. |
| 2 JUL 1200 | 89 | 0.00 | 0.00 | 0.00 | 378. | 625. |
| 2 JUL 1300 | 90 | 0.00 | 0.00 | 0.00 | 372. | 617. |
| 2 JUL 1400 | 91 | 0.00 | 0.00 | 0.00 | 366. | 610. |
| 2 JUL 1500 | 92 | 0.00 | 0.00 | 0.00 | 360. | 602. |
| 2 JUL 1600 | 93 | 0.00 | 0.00 | 0.00 | 354. | 595. |
| 2 JUL 1700 | 94 | 0.00 | 0.00 | 0.00 | 349. | 582. |
| 2 JUL 1800 | 95 | 0.00 | 0.00 | 0.00 | 343. | 568. |
| 2 JUL 1900 | 96 | 0.00 | 0.00 | 0.00 | 337. | 556. |
| 2 JUL 2000 | 97 | 0.00 | 0.00 | 0.00 | 332. | 545. |
| 2 JUL 2100 | 98 | 0.00 | 0.00 | 0.00 | 326. | 535. |
| 2 JUL 2200 | 99 | 0.00 | 0.00 | 0.00 | 321. | 523. |
| 2 JUL 2300 | 100 | 0.00 | 0.00 | 0.00 | 316. | 516. |
| 3 JUL 0000 | 101 | 0.00 | 0.00 | 0.00 | 311. | 509. |
| 3 JUL 0100 | 102 | 0.00 | 0.00 | 0.00 | 306. | 505. |
| 3 JUL 0200 | 103 | 0.00 | 0.00 | 0.00 | 301. | 500. |
| 3 JUL 0300 | 104 | 0.00 | 0.00 | 0.00 | 296. | 495. |
| 3 JUL 0400 | 105 | 0.00 | 0.00 | 0.00 | 291. | 491. |
| 3 JUL 0500 | 106 | 0.00 | 0.00 | 0.00 | 286. | 488. |
| 3 JUL 0600 | 107 | 0.00 | 0.00 | 0.00 | 282. | 486. |
| 3 JUL 0700 | 108 | 0.00 | 0.00 | 0.00 | 277. | 484. |
| 3 JUL 0800 | 109 | 0.00 | 0.00 | 0.00 | 273. | 482. |
| 3 JUL 0900 | 110 | 0.00 | 0.00 | 0.00 | 268. | 480. |

TOTAL RAINFALL = 2.99, TOTAL LOSS = 1.86, TOTAL EXCESS = 1.13

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 109.00-HR |
|---|---|---|---|---|---|---|
| 3519. | 24.00 | (CFS) | 3503. | 3016. | 1664. | 1197. |
| | | (INCHES) | 0.195 | 0.672 | 1.112 | 1.210 |
| | | (AC-FT) | 1737. | 5982. | 9901. | 10761. |

CUMULATIVE AREA = 167.00 SQ MI


STATION WOAV
(O) OUTFLOW, (*) OBSERVED FLOW
0. 400. 800. 1200. 1600. 2000. 2400. 2800. 3200. 3600. 4000. 0. 0.
(L) PRECIP. (X) EXCESS
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 1.2 0.8 0.4 0.0
DAHRMN PER

```
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

ID        CHARLOTTE CREEK 12-21-73
ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
IT      60 20DEC73    1800      67
IO       1       2
OU       1      35
PG     KOR    2.23
PG     OSU    2.37
PG     COB    2.10
PG     STM    3.06
PG     DAV
PI     .08     .02     .10     .11     .14     .13     .07     .10     .05     .10
PI     .05     .08     .15     .12     .07     .13     .10     .06     .07     .03
PI     .00     .06     .08     .04     .09     .07     .03     .02     .01     .02
PI     .03     .00     .00     .00     .00     .00     .00     .00     .00     .00

KK    WDAV
QO     302     312     322     358     394     497     600     786     972    1156
QO    1340    1460    1580    1928    2276    2692    3108    3405    3702    3790
QO    3879    3961    4044    4165    4286    4299    4140    3894    3647    3317
QO    2987    2709    2430    2267    2103    1992    1880    1800    1720    1671
QO    1622    1584    1545    1524    1503    1475    1447    1423    1398    1363
QO    1323    1301    1274    1259    1244    1229    1214    1202    1190    1175
QO    1160    1145    1130    1124    1118    1106    1094       0       0       0
PT     KOR     OSU     COB     STM     DAV
PW     .17     .02     .07     .19     .55
PR     DAV
PW    1.00
BA    167.      0.
BF    302.   1250.  1.0165
UC    -10.    -12.
LU     -.4    -.03
ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 1 THROUGH 35)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.028 | | 15.56 | | | |
| COMPUTED HYDROGRAPH | 83096. | 0.771 | 2374. | 22.91 | 7.36 | 4078. | 20.00 |
| OBSERVED HYDROGRAPH | 83107. | 0.771 | 2374. | 22.54 | 6.98 | 4299. | 25.00 |
| DIFFERENCE | -11. | -0.000 | -0. | 0.37 | 0.37 | -221. | -5.00 |
| PERCENT DIFFERENCE | -0.01 | | | | 5.35 | -5.14 | |

STANDARD ERROR 291. AVERAGE ABSOLUTE ERROR 224.
OBJECTIVE FUNCTION 313. AVERAGE PERCENT ABSOLUTE ERROR 12.68

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 67)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.028 | | 15.56 | | | |
| COMPUTED HYDROGRAPH | 125636. | 1.166 | 1875. | 31.68 | 16.13 | 4078. | 20.00 |
| OBSERVED HYDROGRAPH | 127347. | 1.182 | 1901. | 32.06 | 16.51 | 4299. | 25.00 |
| DIFFERENCE | -1711. | -0.016 | -26. | -0.38 | -0.38 | -221. | -5.00 |
| PERCENT DIFFERENCE | -1.34 | | | | -2.31 | -5.14 | |

STANDARD ERROR 254. AVERAGE ABSOLUTE ERROR 206.
OBJECTIVE FUNCTION 287. AVERAGE PERCENT ABSOLUTE ERROR 12.97

UNIT HYDROGRAPH
83 END-OF-PERIOD ORDINATES

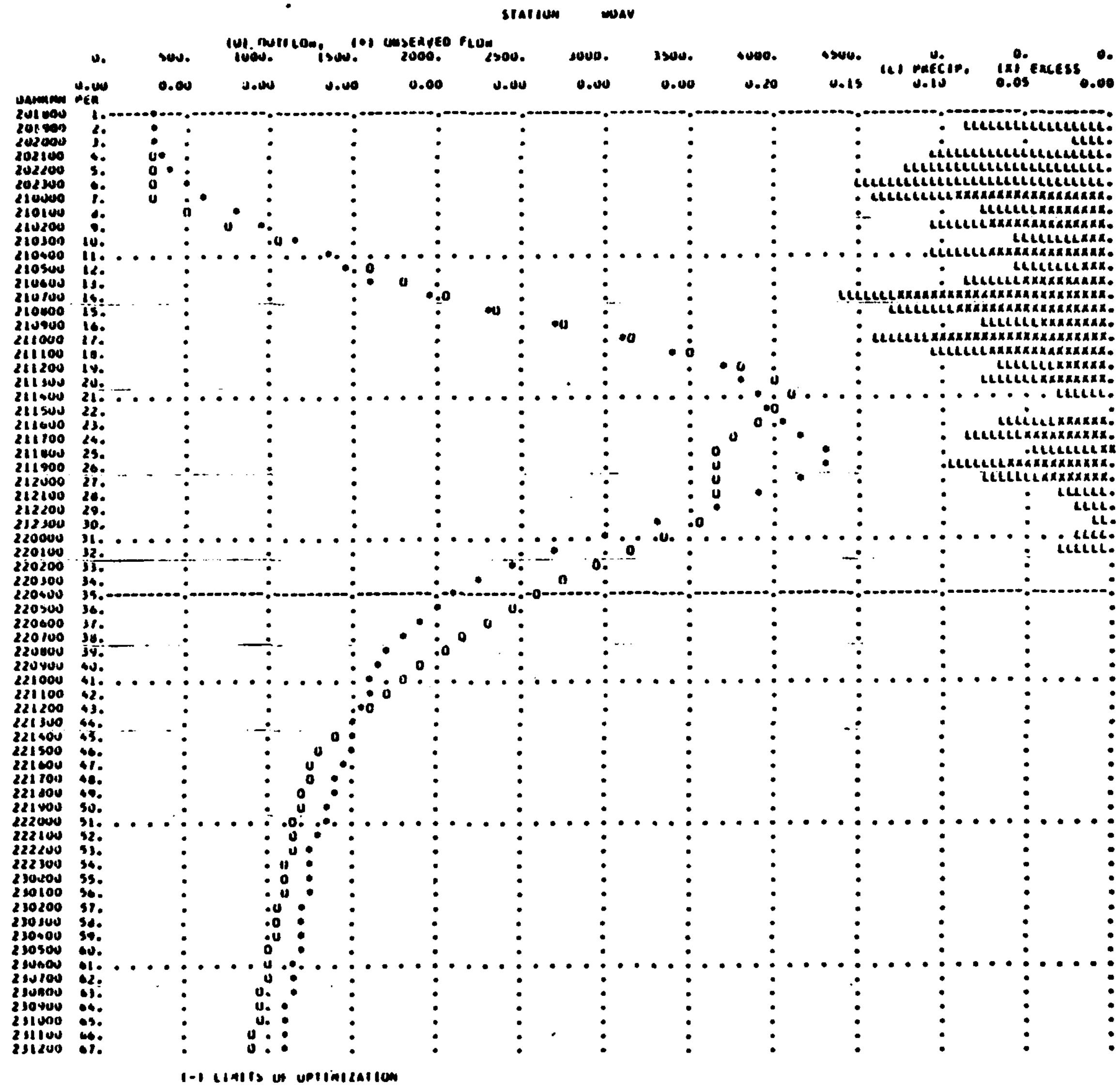
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 562. | 2114. | 4101. | 5627. | 6016. | 5687. | 5325. | 4986. | 4668. | 4371. |
| 4093. | 3833. | 3588. | 3360. | 3146. | 2946. | 2759. | 2583. | 2419. | 2265. |
| 2121. | 1986. | 1859. | 1741. | 1630. | 1526. | 1429. | 1338. | 1253. | 1173. |
| 1099. | 1029. | 963. | 902. | 845. | 791. | 741. | 693. | 649. | 608. |
| 569. | 533. | 499. | 467. | 438. | 410. | 384. | 359. | 336. | 315. |
| 295. | 276. | 259. | 242. | 227. | 212. | 199. | 186. | 174. | 163. |
| 153. | 143. | 134. | 125. | 117. | 110. | 103. | 96. | 90. | 85. |
| 79. | 74. | 69. | 65. | 61. | 57. | 53. | 50. | 47. | 44. |
| 41. | 38. | 36. | | | | | | | |

HYDROGRAPH AT STATION  #DAV

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 20 DEC 1800 | 1 | 0.00 | 0.00 | 0.00 | 302. | 302. |
| 20 DEC 1900 | 2 | 0.09 | 0.09 | 0.00 | 297. | 312. |
| 20 DEC 2000 | 3 | 0.02 | 0.02 | 0.00 | 292. | 322. |
| 20 DEC 2100 | 4 | 0.11 | 0.11 | 0.00 | 288. | 358. |
| 20 DEC 2200 | 5 | 0.12 | 0.12 | 0.00 | 283. | 394. |
| 20 DEC 2300 | 6 | 0.15 | 0.15 | 0.00 | 278. | 497. |
| 21 DEC 0000 | 7 | 0.14 | 0.05 | 0.09 | 323. | 600. |
| 21 DEC 0100 | 8 | 0.08 | 0.04 | 0.04 | 477. | 786. |
| 21 DEC 0200 | 9 | 0.11 | 0.04 | 0.07 | 747. | 972. |
| 21 DEC 0300 | 10 | 0.05 | 0.04 | 0.02 | 1072. | 1156. |
| 21 DEC 0400 | 11 | 0.11 | 0.04 | 0.07 | 1368. | 1340. |
| 21 DEC 0500 | 12 | 0.05 | 0.04 | 0.02 | 1611. | 1460. |
| 21 DEC 0600 | 13 | 0.09 | 0.04 | 0.05 | 1810. | 1580. |
| 21 DEC 0700 | 14 | 0.16 | 0.04 | 0.12 | 2034. | 1928. |
| 21 DEC 0800 | 15 | 0.13 | 0.04 | 0.09 | 2354. | 2276. |
| 21 DEC 0900 | 16 | 0.08 | 0.04 | 0.04 | 2752. | 2692. |
| 21 DEC 1000 | 17 | 0.14 | 0.04 | 0.10 | 3162. | 3108. |
| 21 DEC 1100 | 18 | 0.11 | 0.04 | 0.07 | 3517. | 3405. |
| 21 DEC 1200 | 19 | 0.06 | 0.04 | 0.03 | 3794. | 3702. |
| 21 DEC 1300 | 20 | 0.08 | 0.04 | 0.04 | 3997. | 3790. |
| 21 DEC 1400 | 21 | 0.03 | 0.03 | 0.00 | 4078. | 3878. |
| 21 DEC 1500 | 22 | 0.00 | 0.00 | 0.00 | 4019. | 3961. |
| 21 DEC 1600 | 23 | 0.06 | 0.04 | 0.03 | 3882. | 4044. |
| 21 DEC 1700 | 24 | 0.09 | 0.04 | 0.05 | 3747. | 4165. |
| 21 DEC 1800 | 25 | 0.04 | 0.04 | 0.01 | 3661. | 4286. |
| 21 DEC 1900 | 26 | 0.10 | 0.04 | 0.06 | 3636. | 4299. |
| 21 DEC 2000 | 27 | 0.08 | 0.04 | 0.04 | 3653. | 4140. |
| 21 DEC 2100 | 28 | 0.03 | 0.03 | 0.00 | 3668. | 3894. |
| 21 DEC 2200 | 29 | 0.02 | 0.02 | 0.00 | 3640. | 3647. |
| 21 DEC 2300 | 30 | 0.01 | 0.01 | 0.00 | 3531. | 3317. |
| 22 DEC 0000 | 31 | 0.02 | 0.02 | 0.00 | 3347. | 2987. |
| 22 DEC 0100 | 32 | 0.03 | 0.03 | 0.00 | 3145. | 2709. |
| 22 DEC 0200 | 33 | 0.00 | 0.00 | 0.00 | 2954. | 2430. |
| 22 DEC 0300 | 34 | 0.00 | 0.00 | 0.00 | 2774. | 2267. |
| 22 DEC 0400 | 35 | 0.00 | 0.00 | 0.00 | 2606. | 2104. |
| 22 DEC 0500 | 36 | 0.00 | 0.00 | 0.00 | 2448. | 1992. |
| 22 DEC 0600 | 37 | 0.00 | 0.00 | 0.00 | 2300. | 1880. |
| 22 DEC 0700 | 38 | 0.00 | 0.00 | 0.00 | 2162. | 1800. |
| 22 DEC 0800 | 39 | 0.00 | 0.00 | 0.00 | 2032. | 1720. |
| 22 DEC 0900 | 40 | 0.00 | 0.00 | 0.00 | 1911. | 1671. |
| 22 DEC 1000 | 41 | 0.00 | 0.00 | 0.00 | 1797. | 1622. |
| 22 DEC 1100 | 42 | 0.00 | 0.00 | 0.00 | 1690. | 1584. |
| 22 DEC 1200 | 43 | 0.00 | 0.00 | 0.00 | 1589. | 1545. |
| 22 DEC 1300 | 44 | 0.00 | 0.00 | 0.00 | 1495. | 1524. |
| 22 DEC 1400 | 45 | 0.00 | 0.00 | 0.00 | 1407. | 1503. |
| 22 DEC 1500 | 46 | 0.00 | 0.00 | 0.00 | 1325. | 1475. |
| 22 DEC 1600 | 47 | 0.00 | 0.00 | 0.00 | 1249. | 1447. |
| 22 DEC 1700 | 48 | 0.00 | 0.00 | 0.00 | 1229. | 1423. |
| 22 DEC 1800 | 49 | 0.00 | 0.00 | 0.00 | 1209. | 1398. |
| 22 DEC 1900 | 50 | 0.00 | 0.00 | 0.00 | 1189. | 1363. |
| 22 DEC 2000 | 51 | 0.00 | 0.00 | 0.00 | 1170. | 1328. |
| 22 DEC 2100 | 52 | 0.00 | 0.00 | 0.00 | 1151. | 1301. |
| 22 DEC 2200 | 53 | 0.00 | 0.00 | 0.00 | 1132. | 1274. |
| 22 DEC 2300 | 54 | 0.00 | 0.00 | 0.00 | 1114. | 1259. |
| 23 DEC 0000 | 55 | 0.00 | 0.00 | 0.00 | 1096. | 1244. |
| 23 DEC 0100 | 56 | 0.00 | 0.00 | 0.00 | 1078. | 1229. |
| 23 DEC 0200 | 57 | 0.00 | 0.00 | 0.00 | 1061. | 1214. |
| 23 DEC 0300 | 58 | 0.00 | 0.00 | 0.00 | 1043. | 1202. |
| 23 DEC 0400 | 59 | 0.00 | 0.00 | 0.00 | 1027. | 1190. |
| 23 DEC 0500 | 60 | 0.00 | 0.00 | 0.00 | 1010. | 1175. |
| 23 DEC 0600 | 61 | 0.00 | 0.00 | 0.00 | 993. | 1160. |
| 23 DEC 0700 | 62 | 0.00 | 0.00 | 0.00 | 977. | 1145. |
| 23 DEC 0800 | 63 | 0.00 | 0.00 | 0.00 | 961. | 1130. |
| 23 DEC 0900 | 64 | 0.00 | 0.00 | 0.00 | 946. | 1124. |
| 23 DEC 1000 | 65 | 0.00 | 0.00 | 0.00 | 931. | 1118. |
| 23 DEC 1100 | 66 | 0.00 | 0.00 | 0.00 | 915. | 1106. |
| 23 DEC 1200 | 67 | 0.00 | 0.00 | 0.00 | 901. | 1094. |

TOTAL RAINFALL = 2.37, TOTAL LOSS = 1.34, TOTAL EXCESS = 1.03

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 66.00-HR |
|---|---|---|---|---|---|---|
| 4078. | 20.30 | (CFS) | 1908. | 3282. | 1894. | 1894. |
| | | (INCHES) | 0.218 | 0.731 | 1.160 | 1.160 |
| | | (AC-FT) | 1938. | 6509. | 13333. | 13333. |


STATION
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP. (X) EXCESS
(-) LIMITS OF OPTIMIZATION

```
                                   HEC-1 INPUT                                                  PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        COREY CREEK     11-14-72
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3           IT      60 13NOV72    1800      45
  4           IO       1       2
  5           OU       8      18
  6           PG  CANTON    1.83
  7           PG  COVING    2.06
  8           PG    TROY    2.06
  9           PG  JACSUM
 10           PI     .00     .02     .05     .03     .00     .01     .04     .05     .15     .15
 11           PI     .02     .13     .15     .20     .10     .10     .05     .05     .00     .00
 12           PI     .00     .00     .01     .00     .00     .00     .01     .01     .02     .02
 13           PI     .02     .01     .00     .00     .01     .00     .00     .00     .00     .00

 14           KK   COREY
 15           QO       7       7       8       8       8       9       9      13      18      36
 16           QO      64      93     127     180     240     259     276     302     326     269
 17           QO     218     174     133     118     102     100      98      96      93      89
 18           QO      85      80      75      71      67      64      60      57      54      52
 19           QO      49      47      45      44      43       0       0       0       0       0
 20           PT  CANTON  COVING    TROY
 21           PW     .28     .69     .04
 22           PR  JACSUM
 23           PW     1.0
 24           BA    12.2      0.
 25           BF      7.     46.  1.0335
 26           UC     -3.     -7.
 27           LU     -.8    -.11
 28           ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 8 THROUGH 18)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.544 | | 13.24 | | | |
| COMPUTED HYDROGRAPH | 1610. | 0.204 | 146. | 15.26 | 2.02 | 293. | 16.00 |
| OBSERVED HYDROGRAPH | 1608. | 0.204 | 146. | 15.23 | 1.99 | 302. | 17.00 |
| DIFFERENCE | 2. | 0.000 | 0. | 0.03 | 0.03 | -9. | -1.00 |
| PERCENT DIFFERENCE | 0.10 | | | | 1.69 | -3.06 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 16. | AVERAGE ABSOLUTE ERROR | 15. |
| OBJECTIVE FUNCTION | 18. | AVERAGE PERCENT ABSOLUTE ERROR | 21.74 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 45)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.544 | | 13.24 | | | |
| COMPUTED HYDROGRAPH | 4318. | 0.549 | 96. | 22.52 | 9.28 | 293. | 16.00 |
| OBSERVED HYDROGRAPH | 4373. | 0.555 | 97. | 22.76 | 9.52 | 326. | 18.00 |
| DIFFERENCE | -55. | -0.007 | -1. | -0.24 | -0.24 | -33. | -2.00 |
| PERCENT DIFFERENCE | -1.25 | | | | -2.51 | -10.20 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 20. | AVERAGE ABSOLUTE ERROR | 14. |
| OBJECTIVE FUNCTION | 25. | AVERAGE PERCENT ABSOLUTE ERROR | 18.57 |

UNIT HYDROGRAPH
56 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 249. | 579. | 644. | 588. | 534. | 485. | 441. | 400. | 363. | 330. |
| 300. | 272. | 247. | 225. | 204. | 185. | 168. | 153. | 139. | 126. |
| 114. | 104. | 94. | 86. | 78. | 71. | 64. | 58. | 53. | 48. |
| 44. | 40. | 36. | 33. | 30. | 27. | 24. | 22. | 20. | 18. |
| 17. | 15. | 14. | 12. | 11. | 10. | 9. | 8. | 8. | 7. |
| 6. | 6. | 5. | 5. | 4. | 4. | | | | |

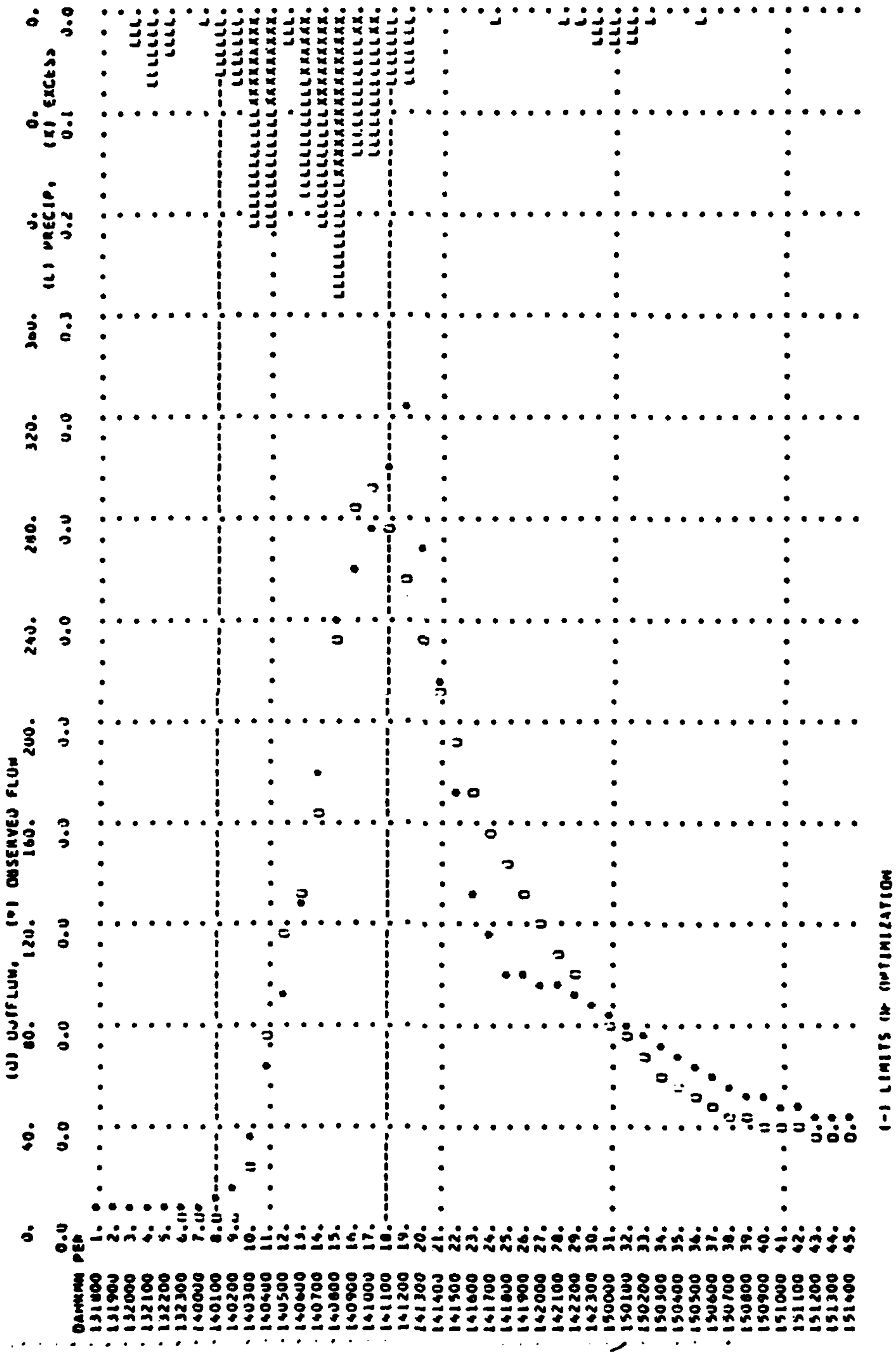
HYDROGRAPH AT STATION CUREY

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 NOV 1800 | 1 | 0.00 | 0.00 | 0.00 | 7. | 7. | 14 NOV 1700 | 24 | 0.01 | 0.01 | 0.00 | 158. | 116. |
| 13 NOV 1900 | 2 | 0.00 | 0.00 | 0.00 | 7. | 7. | 14 NOV 1800 | 25 | 0.00 | 0.00 | 0.00 | 144. | 102. |
| 13 NOV 2000 | 3 | 0.03 | 0.03 | 0.00 | 7. | 8. | 14 NOV 1900 | 26 | 0.00 | 0.00 | 0.00 | 131. | 100. |
| 13 NOV 2100 | 4 | 0.07 | 0.07 | 0.00 | 6. | 8. | 14 NOV 2000 | 27 | 0.00 | 0.00 | 0.00 | 119. | 98. |
| 13 NOV 2200 | 5 | 0.04 | 0.04 | 0.00 | 6. | 8. | 14 NOV 2100 | 28 | 0.01 | 0.01 | 0.00 | 108. | 90. |
| 13 NOV 2300 | 6 | 0.00 | 0.00 | 0.00 | 6. | 9. | 14 NOV 2200 | 29 | 0.01 | 0.01 | 0.00 | 99. | 83. |
| 14 NOV 0000 | 7 | 0.01 | 0.01 | 0.00 | 6. | 9. | 14 NOV 2300 | 30 | 0.03 | 0.03 | 0.00 | 89. | 89. |
| 14 NOV 0100 | 8 | 0.06 | 0.06 | 0.00 | 6. | 13. | 15 NOV 0000 | 31 | 0.03 | 0.03 | 0.00 | 81. | 85. |
| 14 NOV 0200 | 9 | 0.07 | 0.07 | 0.00 | 5. | 18. | 15 NOV 0100 | 32 | 0.03 | 0.03 | 0.00 | 74. | 80. |
| 14 NOV 0300 | 10 | 0.21 | 0.13 | 0.08 | 26. | 36. | 15 NOV 0200 | 33 | 0.01 | 0.01 | 0.00 | 67. | 75. |
| 14 NOV 0400 | 11 | 0.21 | 0.12 | 0.09 | 77. | 64. | 15 NOV 0300 | 34 | 0.00 | 0.00 | 0.00 | 61. | 71. |
| 14 NOV 0500 | 12 | 0.03 | 0.03 | 0.00 | 114. | 93. | 15 NOV 0400 | 35 | 0.00 | 0.00 | 0.00 | 56. | 67. |
| 14 NOV 0600 | 13 | 0.18 | 0.12 | 0.06 | 131. | 127. | 15 NOV 0500 | 36 | 0.01 | 0.01 | 0.00 | 51. | 64. |
| 14 NOV 0700 | 14 | 0.21 | 0.12 | 0.09 | 165. | 180. | 15 NOV 0600 | 37 | 0.00 | 0.00 | 0.00 | 46. | 60. |
| 14 NOV 0800 | 15 | 0.28 | 0.12 | 0.16 | 231. | 240. | 15 NOV 0700 | 38 | 0.00 | 0.00 | 0.00 | 45. | 57. |
| 14 NOV 0900 | 16 | 0.14 | 0.12 | 0.02 | 285. | 259. | 15 NOV 0800 | 39 | 0.00 | 0.00 | 0.00 | 43. | 54. |
| 14 NOV 1000 | 17 | 0.14 | 0.12 | 0.02 | 293. | 276. | 15 NOV 0900 | 40 | 0.00 | 0.00 | 0.00 | 42. | 52. |
| 14 NOV 1100 | 18 | 0.07 | 0.07 | 0.00 | 277. | 302. | 15 NOV 1000 | 41 | 0.00 | 0.00 | 0.00 | 40. | 49. |
| 14 NOV 1200 | 19 | 0.07 | 0.07 | 0.00 | 254. | 325. | 15 NOV 1100 | 42 | 0.00 | 0.00 | 0.00 | 39. | 47. |
| 14 NOV 1300 | 20 | 0.00 | 0.00 | 0.00 | 231. | 269. | 15 NOV 1200 | 43 | 0.00 | 0.00 | 0.00 | 38. | 45. |
| 14 NOV 1400 | 21 | 0.00 | 0.00 | 0.00 | 210. | 218. | 15 NOV 1300 | 44 | 0.00 | 0.00 | 0.00 | 37. | 44. |
| 14 NOV 1500 | 22 | 0.00 | 0.00 | 0.00 | 191. | 174. | 15 NOV 1400 | 45 | 0.00 | 0.00 | 0.00 | 35. | 43. |
| 14 NOV 1600 | 23 | 0.00 | 0.00 | 0.00 | 174. | 133. | | | | | | | |

TOTAL RAINFALL = 2.00, TOTAL LOSS = 1.45, TOTAL EXCESS = 0.54

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 44.00-HR |
|---|---|---|---|---|---|---|
| 293. | 16.00 | (CFS) | 260. | 156. | 98. | 98. |
| | | (INCHES) | 0.198 | 0.477 | 0.546 | 0.546 |
| | | (AC-FT) | 129. | 310. | 355. | 355. |

CUMULATIVE AREA = 12.20 SQ MI


STATION COREY
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS
(-) LIMITS OF OPTIMIZATION
DAHRMN PER

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                                   HEC-1 INPUT                                                          PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        COREY CREEK      9-26-75
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3           IT      60 24SEP75     0300      70
  4           IO       1       2
  5           QO      45      57
  6           PG  CANTON    6.92
  7           PG  COVING    5.69
  8           PG    TROY    6.96
  9           PG  JACSUM
 10           PI     .10     .10     .20     .10     .20     .10     .00     .00     .00     .00
 11           PI     .00     .00     .00     .10     .00     .00     .00     .00     .00     .10
 12           PI     .00     .10     .00     .00     .10     .10     .20     .20     .10     .30
 13           PI     .00     .10     .10     .00     .00     .10     .00     .10     .20     .10
 14           PI     .10     .00     .00     .00     .40     .30     .50     .30     .50     .40
 15           PI     .10     .20     .10     .10     .10     .00     .00     .00     .00     .00

 16           KK   COREY
 17           QO       2       3       4       6      10      33      82     101      92      71
 18           QO      55      40      35      28      25      23      21      19      18      17
 19           QO      17      24      40      62      69      65      70     102     197     388
 20           QO     433     402     349     314     283     238     202     180     180     337
 21           QO     378     393     334     288     244     290     509    1190    1707    2126
 22           QO    2094    2062    2038    1370    1069     895     797     547     409     309
 23           QO     277     246     221     206     183     168     160     148     144     136
 24           PT  CANTON  COVING    TROY
 25           PW     .28     .68     .04
 26           PR  JACSUM
 27           PW     1.0
 28           BA    12.2      0.
 29           BF      2.    150.  1.0335
 30           UC    -2.2     -3.
 31           LU     -.4    -.08
 32           ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 45 THROUGH 57)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.266 | | 41.90 | | | |
| COMPUTED HYDROGRAPH | 16359. | 2.078 | 1258. | 51.58 | 9.68 | 2237. | 51.00 |
| OBSERVED HYDROGRAPH | 16391. | 2.082 | 1261. | 51.59 | 9.69 | 2126. | 49.00 |
| DIFFERENCE | -32. | -0.004 | -2. | -0.01 | -0.01 | 111. | 2.00 |
| PERCENT DIFFERENCE | -0.20 | | | | -0.08 | 5.23 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 123. | AVERAGE ABSOLUTE ERROR | 108. |
| OBJECTIVE FUNCTION | 128. | AVERAGE PERCENT ABSOLUTE ERROR | 12.05 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 70)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.266 | | 41.90 | | | |
| COMPUTED HYDROGRAPH | 27608. | 3.507 | 394. | 44.79 | 2.89 | 2237. | 51.00 |
| OBSERVED HYDROGRAPH | 25580. | 3.249 | 365. | 48.46 | 6.56 | 2126. | 49.00 |
| DIFFERENCE | 2028. | 0.258 | 29. | -3.67 | -3.67 | 111. | 2.00 |
| PERCENT DIFFERENCE | 7.93 | | | | -55.96 | 5.23 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 62. | AVERAGE ABSOLUTE ERROR | 32. |
| OBJECTIVE FUNCTION | 107. | AVERAGE PERCENT ABSOLUTE ERROR | 19.87 |

UNIT HYDROGRAPH
16 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 598. | 1507. | 1755. | 1278. | 880. | 606. | 417. | 287. | 198. | 136. |
| 95. | 64. | 44. | 31. | 21. | 14. | | | | |

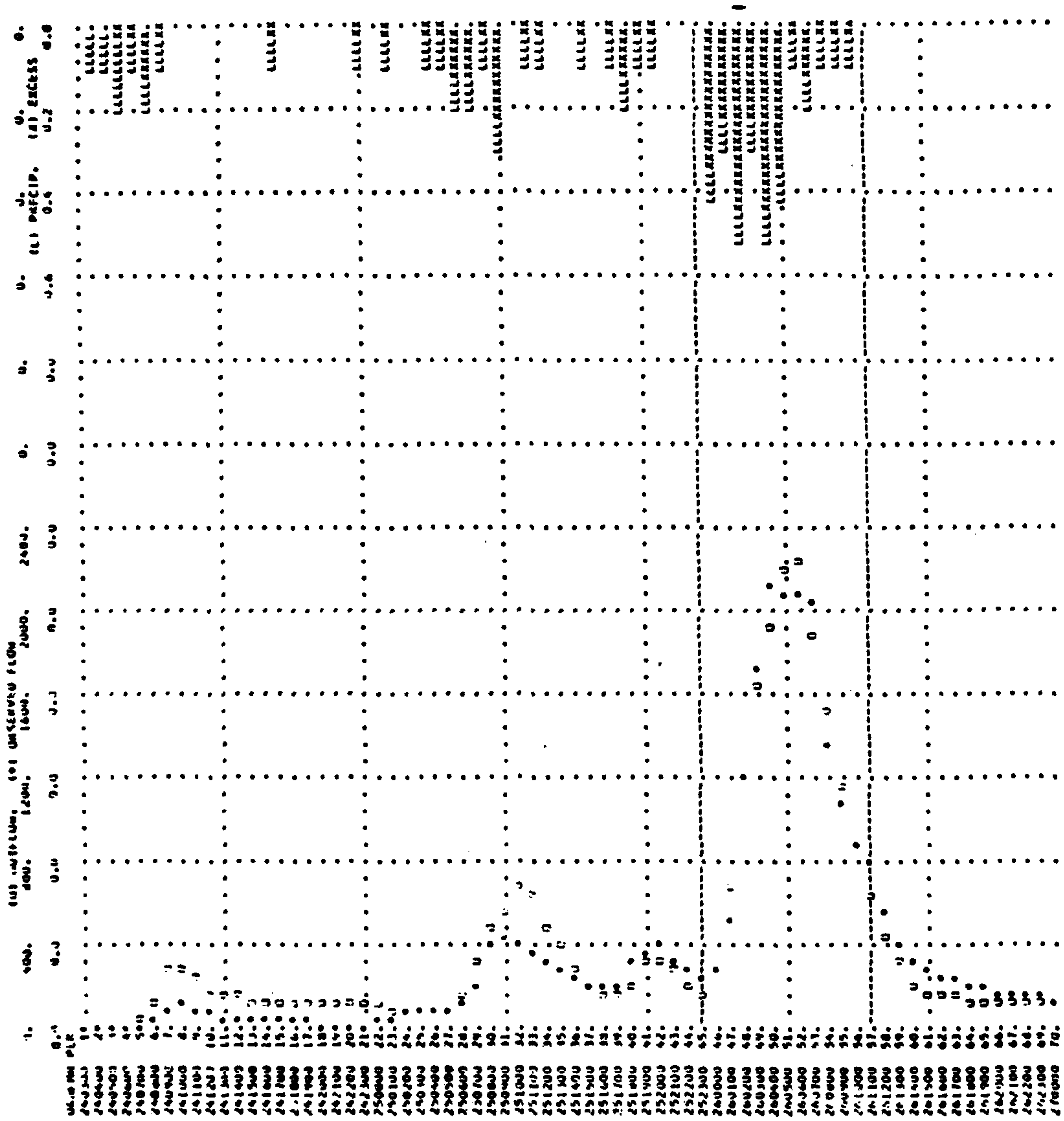
HYDROGRAPH AT STATION COMEY

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 SEP 0300 | 1 | 0.00 | 0.00 | 0.00 | 2. | 2. | 25 SEP 1400 | 36 | 0.00 | 0.00 | 0.00 | 283. | 238. |
| 24 SEP 0400 | 2 | 0.10 | 0.10 | 0.00 | 2. | 1. | 25 SEP 1500 | 37 | 0.10 | 0.08 | 0.02 | 208. | 202. |
| 24 SEP 0500 | 3 | 0.10 | 0.10 | 0.00 | 2. | 4. | 25 SEP 1600 | 38 | 0.00 | 0.00 | 0.00 | 169. | 180. |
| 24 SEP 0600 | 4 | 0.21 | 0.19 | 0.02 | 10. | 6. | 25 SEP 1700 | 39 | 0.10 | 0.08 | 0.02 | 149. | 180. |
| 24 SEP 0700 | 5 | 0.10 | 0.08 | 0.02 | 37. | 13. | 25 SEP 1800 | 40 | 0.21 | 0.08 | 0.13 | 190. | 337. |
| 24 SEP 0800 | 6 | 0.21 | 0.08 | 0.13 | 124. | 33. | 25 SEP 1900 | 41 | 0.10 | 0.08 | 0.02 | 304. | 378. |
| 24 SEP 0900 | 7 | 0.10 | 0.08 | 0.02 | 262. | 82. | 25 SEP 2000 | 42 | 0.10 | 0.08 | 0.02 | 338. | 393. |
| 24 SEP 1000 | 8 | 0.00 | 0.00 | 0.00 | 298. | 101. | 25 SEP 2100 | 43 | 0.00 | 0.00 | 0.00 | 283. | 334. |
| 24 SEP 1100 | 9 | 0.00 | 0.00 | 0.00 | 231. | 92. | 25 SEP 2200 | 44 | 0.00 | 0.00 | 0.00 | 217. | 288. |
| 24 SEP 1200 | 10 | 0.00 | 0.00 | 0.00 | 161. | 71. | 25 SEP 2300 | 45 | 0.00 | 0.00 | 0.00 | 150. | 244. |
| 24 SEP 1300 | 11 | 0.00 | 0.00 | 0.00 | 146. | 55. | 26 SEP 0000 | 46 | 0.41 | 0.08 | 0.33 | 269. | 290. |
| 24 SEP 1400 | 12 | 0.00 | 0.00 | 0.00 | 141. | 40. | 26 SEP 0100 | 47 | 0.31 | 0.08 | 0.23 | 683. | 509. |
| 24 SEP 1500 | 13 | 0.00 | 0.00 | 0.00 | 137. | 35. | 26 SEP 0200 | 48 | 0.52 | 0.08 | 0.43 | 1194. | 1190. |
| 24 SEP 1600 | 14 | 0.00 | 0.00 | 0.00 | 132. | 28. | 26 SEP 0300 | 49 | 0.31 | 0.08 | 0.23 | 1629. | 1707. |
| 24 SEP 1700 | 15 | 0.10 | 0.08 | 0.02 | 128. | 25. | 26 SEP 0400 | 50 | 0.52 | 0.08 | 0.43 | 1935. | 2126. |
| 24 SEP 1800 | 16 | 0.00 | 0.00 | 0.00 | 124. | 23. | 26 SEP 0500 | 51 | 0.41 | 0.08 | 0.33 | 2199. | 2094. |
| 24 SEP 1900 | 17 | 0.00 | 0.00 | 0.00 | 120. | 21. | 26 SEP 0600 | 52 | 0.10 | 0.08 | 0.02 | 2237. | 2062. |
| 24 SEP 2000 | 18 | 0.00 | 0.00 | 0.00 | 116. | 19. | 26 SEP 0700 | 53 | 0.21 | 0.08 | 0.13 | 1898. | 2038. |
| 24 SEP 2100 | 19 | 0.00 | 0.00 | 0.00 | 112. | 18. | 26 SEP 0800 | 54 | 0.10 | 0.08 | 0.02 | 1503. | 1370. |
| 24 SEP 2200 | 20 | 0.00 | 0.00 | 0.00 | 109. | 17. | 26 SEP 0900 | 55 | 0.10 | 0.08 | 0.02 | 1163. | 1069. |
| 24 SEP 2300 | 21 | 0.10 | 0.08 | 0.02 | 105. | 17. | 26 SEP 1000 | 56 | 0.10 | 0.08 | 0.02 | 862. | 895. |
| 25 SEP 0000 | 22 | 0.00 | 0.00 | 0.00 | 102. | 24. | 26 SEP 1100 | 57 | 0.00 | 0.00 | 0.00 | 637. | 797. |
| 25 SEP 0100 | 23 | 0.10 | 0.08 | 0.02 | 98. | 40. | 26 SEP 1200 | 58 | 0.00 | 0.00 | 0.00 | 456. | 547. |
| 25 SEP 0200 | 24 | 0.00 | 0.00 | 0.00 | 95. | 62. | 26 SEP 1300 | 59 | 0.00 | 0.00 | 0.00 | 315. | 409. |
| 25 SEP 0300 | 25 | 0.00 | 0.00 | 0.00 | 92. | 69. | 26 SEP 1400 | 60 | 0.00 | 0.00 | 0.00 | 217. | 309. |
| 25 SEP 0400 | 26 | 0.10 | 0.08 | 0.02 | 89. | 65. | 26 SEP 1500 | 61 | 0.00 | 0.00 | 0.00 | 150. | 277. |
| 25 SEP 0500 | 27 | 0.10 | 0.08 | 0.02 | 86. | 70. | 26 SEP 1600 | 62 | 0.00 | 0.00 | 0.00 | 145. | 246. |
| 25 SEP 0600 | 28 | 0.21 | 0.08 | 0.13 | 158. | 102. | 26 SEP 1700 | 63 | 0.00 | 0.00 | 0.00 | 140. | 221. |
| 25 SEP 0700 | 29 | 0.21 | 0.08 | 0.13 | 336. | 197. | 26 SEP 1800 | 64 | 0.00 | 0.00 | 0.00 | 136. | 206. |
| 25 SEP 0800 | 30 | 0.10 | 0.08 | 0.02 | 480. | 388. | 26 SEP 1900 | 65 | 0.00 | 0.00 | 0.00 | 131. | 183. |
| 25 SEP 0900 | 31 | 0.31 | 0.08 | 0.23 | 571. | 438. | 26 SEP 2000 | 66 | 0.00 | 0.00 | 0.00 | 127. | 168. |
| 25 SEP 1000 | 32 | 0.00 | 0.00 | 0.00 | 683. | 402. | 26 SEP 2100 | 67 | 0.00 | 0.00 | 0.00 | 123. | 160. |
| 25 SEP 1100 | 33 | 0.10 | 0.08 | 0.02 | 647. | 349. | 26 SEP 2200 | 68 | 0.00 | 0.00 | 0.00 | 119. | 148. |
| 25 SEP 1200 | 34 | 0.10 | 0.08 | 0.02 | 499. | 314. | 26 SEP 2300 | 69 | 0.00 | 0.00 | 0.00 | 115. | 144. |
| 25 SEP 1300 | 35 | 0.00 | 0.00 | 0.00 | 386. | 283. | 27 SEP 0000 | 70 | 0.00 | 0.00 | 0.00 | 111. | 136. |

TOTAL RAINFALL = 6.09, TOTAL LOSS = 2.82, TOTAL EXCESS = 3.27

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 69.00-HR |
|---|---|---|---|---|---|---|
| 2237. | 51.00 | (CFS) | 1874. | 804. | 399. | 399. |
| | | (INCHES) | 1.428 | 2.467 | 3.499 | 3.499 |
| | | (AC-FT) | 929. | 1602. | 2277. | 2277. |

CUMULATIVE AREA = 12.20 SQ MI



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                                              HEC-1 INPUT                                                        PAGE  1

 LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1          ID        COREY CREEK      10-09-76
   2          ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
   3          IT      60  7OCT76    1000      80
   4          IO       1       2
   5          UU      45      60
   6          PG  CANTON    3.46
   7          PG  COVING    3.15
   8          PG    TROY    3.26
   9          PG  JACSUM
  10          PI     .20     .00     .00     .00     .00     .00     .00     .10     .10     .00
  11          PI     .00     .10     .20     .40     .10     .00     .10     .00     .00     .00
  12          PI     .00     .00     .00     .10     .00     .00     .00     .00     .00     .00
  13          PI     .00     .00     .00     .00     .00     .10     .00     .00     .10     .00
  14          PI     .10     .10     .10     .10     .10     .10     .30     .30     .30     .10
  15          PI     .10     .00     .20     .10     .00     .00     .10     .00     .00     .00

  16          KK   COREY
  17          QO       1       1       1       1       1       1       1       1       1       1
  18          QO       1       1       2       2       2       3       3       3       3       3
  19          QO       4       4       4       4       4       4       3       3       3       3
  20          QO       3       3       3       3       3       3       3       4       3       4
  21          QO       4       6       8      10      16      22      26      38      75     164
  22          QO     259     312     314     277     214     180     155     131     114     102
  23          QO      90      81      72      66      60      55      50      47      44      41
  24          QO      39      36      34      32      31      30      29      27      26      25
  25          PT  CANTON  COVING    TROY
  26          PW     .14     .85     .01
  27          PR  JACSUM
  28          PW     1.0
  29          BA    12.2      0.
  30          BF      1.     35.  1.0335
  31          UC     -4.     -5.
  32          LU    -1.7    -.15
  33          ZZ
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COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 45 THROUGH 60)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.354 | | 49.33 | | | |
| COMPUTED HYDROGRAPH | 2399. | 0.305 | 150. | 53.97 | 4.64 | 328. | 51.00 |
| OBSERVED HYDROGRAPH | 2399. | 0.305 | 150. | 53.70 | 4.36 | 314. | 52.00 |
| DIFFERENCE | 0. | 0.000 | 0. | 0.28 | 0.28 | 14. | -1.00 |
| PERCENT DIFFERENCE | 0.00 | | | | 6.37 | 4.60 | |

STANDARD ERROR 15. AVERAGE ABSOLUTE ERROR 13.
OBJECTIVE FUNCTION 14. AVERAGE PERCENT ABSOLUTE ERROR 26.63

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 80)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.354 | | 49.33 | | | |
| COMPUTED HYDROGRAPH | 3083. | 0.392 | 39. | 56.82 | 7.48 | 328. | 51.00 |
| OBSERVED HYDROGRAPH | 3443. | 0.437 | 43. | 56.62 | 7.29 | 314. | 52.00 |
| DIFFERENCE | -360. | -0.046 | -5. | 0.19 | 0.19 | 14. | -1.00 |
| PERCENT DIFFERENCE | -10.46 | | | | 2.63 | 4.60 | |

STANDARD ERROR 10. AVERAGE ABSOLUTE ERROR 6.
OBJECTIVE FUNCTION 14. AVERAGE PERCENT ABSOLUTE ERROR 26.44

UNIT HYDROGRAPH
24 END-OF-PERIOD ORDINATES

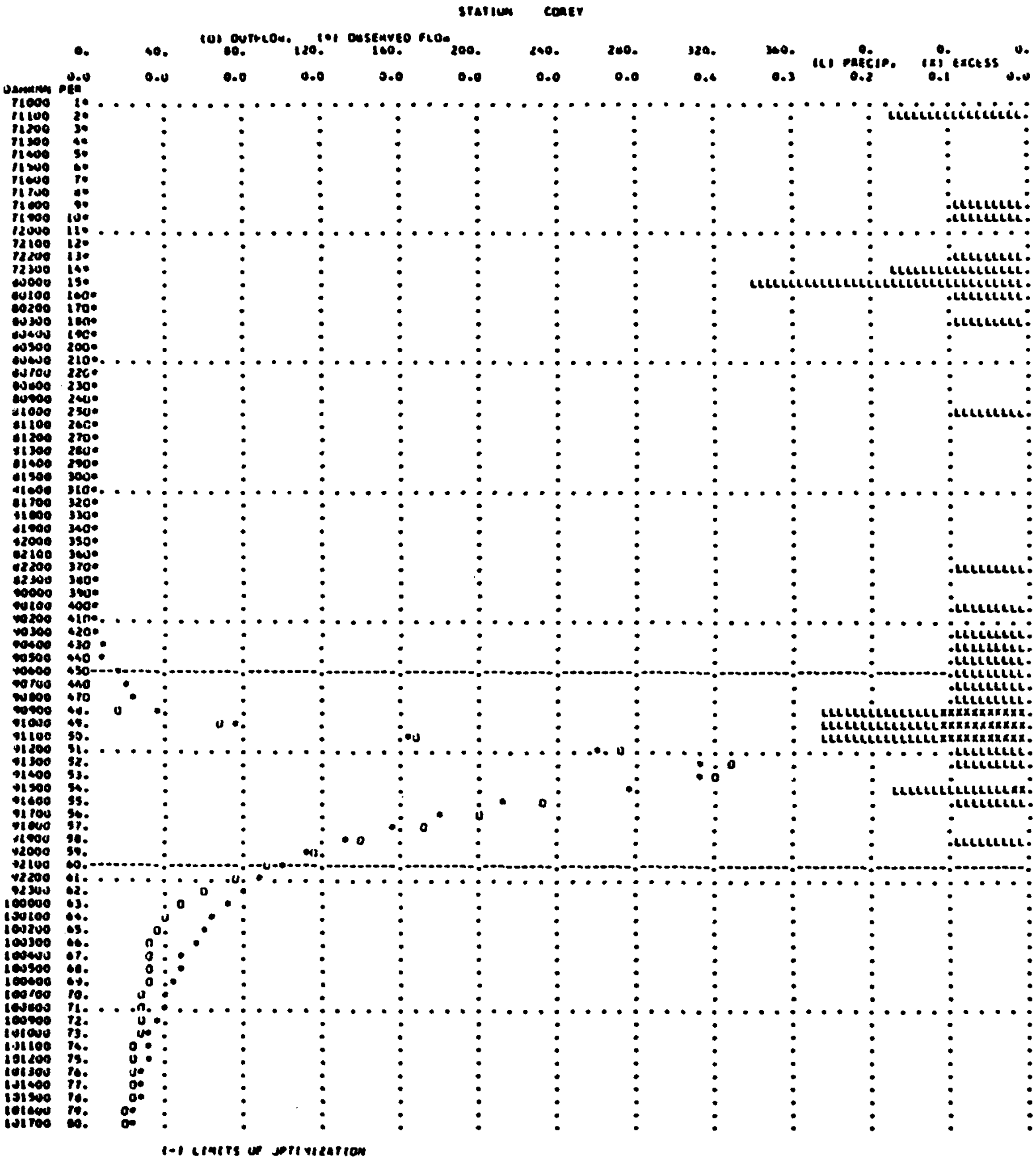
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 135. | 490. | 886. | 1089. | 1009. | 816. | 660. | 534. | 432. | 349. |
| 282. | 228. | 185. | 149. | 121. | 98. | 79. | 64. | 52. | 42. |
| 34. | 27. | 22. | 18. | 14. | 12. | 9. | 8. | | |

HYDROGRAPH AT STATION COREY

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 OCT 1000 | 1 | 0.00 | 0.00 | 0.00 | 1. | 1. | 9 OCT 0200 | 41 | 0.00 | 0.00 | 0.00 | 0. | 4. |
| 7 OCT 1100 | 2 | 0.17 | 0.17 | 0.00 | 1. | 1. | 9 OCT 0300 | 42 | 0.09 | 0.09 | 0.00 | 0. | 6. |
| 7 OCT 1200 | 3 | 0.00 | 0.00 | 0.00 | 1. | 1. | 9 OCT 0400 | 43 | 0.09 | 0.09 | 0.00 | 0. | 8. |
| 7 OCT 1300 | 4 | 0.00 | 0.00 | 0.00 | 1. | 1. | 9 OCT 0500 | 44 | 0.09 | 0.09 | 0.00 | 0. | 10. |
| 7 OCT 1400 | 5 | 0.00 | 0.00 | 0.00 | 1. | 1. | 9 OCT 0600 | 45 | 0.09 | 0.09 | 0.00 | 0. | 16. |
| 7 OCT 1500 | 6 | 0.00 | 0.00 | 0.00 | 1. | 1. | 9 OCT 0700 | 46 | 0.09 | 0.09 | 0.00 | 0. | 22. |
| 7 OCT 1600 | 7 | 0.00 | 0.00 | 0.00 | 1. | 1. | 9 OCT 0800 | 47 | 0.09 | 0.09 | 0.00 | 0. | 26. |
| 7 OCT 1700 | 8 | 0.00 | 0.00 | 0.00 | 1. | 1. | 9 OCT 0900 | 48 | 0.26 | 0.15 | 0.11 | 15. | 38. |
| 7 OCT 1800 | 9 | 0.09 | 0.09 | 0.00 | 1. | 1. | 9 OCT 1000 | 49 | 0.26 | 0.15 | 0.11 | 69. | 75. |
| 7 OCT 1900 | 10 | 0.09 | 0.09 | 0.00 | 1. | 1. | 9 OCT 1100 | 50 | 0.26 | 0.15 | 0.11 | 166. | 164. |
| 7 OCT 2000 | 11 | 0.00 | 0.00 | 0.00 | 1. | 1. | 9 OCT 1200 | 51 | 0.09 | 0.09 | 0.00 | 271. | 259. |
| 7 OCT 2100 | 12 | 0.00 | 0.00 | 0.00 | 1. | 1. | 9 OCT 1300 | 52 | 0.09 | 0.09 | 0.00 | 324. | 312. |
| 7 OCT 2200 | 13 | 0.09 | 0.09 | 0.00 | 1. | 2. | 9 OCT 1400 | 53 | 0.00 | 0.00 | 0.00 | 321. | 316. |
| 7 OCT 2300 | 14 | 0.17 | 0.17 | 0.00 | 1. | 2. | 9 OCT 1500 | 54 | 0.17 | 0.15 | 0.02 | 277. | 277. |
| 8 OCT 0000 | 15 | 0.35 | 0.35 | 0.00 | 1. | 2. | 9 OCT 1600 | 55 | 0.09 | 0.09 | 0.00 | 233. | 214. |
| 8 OCT 0100 | 16 | 0.09 | 0.09 | 0.00 | 1. | 3. | 9 OCT 1700 | 56 | 0.00 | 0.00 | 0.00 | 200. | 180. |
| 8 OCT 0200 | 17 | 0.00 | 0.00 | 0.00 | 1. | 3. | 9 OCT 1800 | 57 | 0.00 | 0.00 | 0.00 | 171. | 155. |
| 8 OCT 0300 | 18 | 0.09 | 0.09 | 0.00 | 1. | 3. | 9 OCT 1900 | 58 | 0.09 | 0.09 | 0.00 | 141. | 131. |
| 8 OCT 0400 | 19 | 0.00 | 0.00 | 0.00 | 1. | 3. | 9 OCT 2000 | 59 | 0.00 | 0.00 | 0.00 | 114. | 114. |
| 8 OCT 0500 | 20 | 0.00 | 0.00 | 0.00 | 1. | 3. | 9 OCT 2100 | 60 | 0.00 | 0.00 | 0.00 | 92. | 102. |
| 8 OCT 0600 | 21 | 0.00 | 0.00 | 0.00 | 1. | 4. | 9 OCT 2200 | 61 | 0.00 | 0.00 | 0.00 | 75. | 90. |
| 8 OCT 0700 | 22 | 0.00 | 0.00 | 0.00 | 1. | 4. | 9 OCT 2300 | 62 | 0.00 | 0.00 | 0.00 | 60. | 81. |
| 8 OCT 0800 | 23 | 0.00 | 0.00 | 0.00 | 0. | 4. | 10 OCT 0000 | 63 | 0.00 | 0.00 | 0.00 | 49. | 72. |
| 8 OCT 0900 | 24 | 0.00 | 0.00 | 0.00 | 0. | 4. | 10 OCT 0100 | 64 | 0.00 | 0.00 | 0.00 | 40. | 66. |
| 8 OCT 1000 | 25 | 0.09 | 0.09 | 0.00 | 0. | 4. | 10 OCT 0200 | 65 | 0.00 | 0.00 | 0.00 | 35. | 60. |
| 8 OCT 1100 | 26 | 0.00 | 0.00 | 0.00 | 0. | 4. | 10 OCT 0300 | 66 | 0.00 | 0.00 | 0.00 | 33. | 55. |
| 8 OCT 1200 | 27 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 0400 | 67 | 0.00 | 0.00 | 0.00 | 32. | 50. |
| 8 OCT 1300 | 28 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 0500 | 68 | 0.00 | 0.00 | 0.00 | 31. | 47. |
| 8 OCT 1400 | 29 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 0600 | 69 | 0.00 | 0.00 | 0.00 | 30. | 44. |
| 8 OCT 1500 | 30 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 0700 | 70 | 0.00 | 0.00 | 0.00 | 29. | 41. |
| 8 OCT 1600 | 31 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 0800 | 71 | 0.00 | 0.00 | 0.00 | 28. | 39. |
| 8 OCT 1700 | 32 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 0900 | 72 | 0.00 | 0.00 | 0.00 | 27. | 36. |
| 8 OCT 1800 | 33 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 1000 | 73 | 0.00 | 0.00 | 0.00 | 27. | 34. |
| 8 OCT 1900 | 34 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 1100 | 74 | 0.00 | 0.00 | 0.00 | 26. | 32. |
| 8 OCT 2000 | 35 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 1200 | 75 | 0.00 | 0.00 | 0.00 | 25. | 31. |
| 8 OCT 2100 | 36 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 1300 | 76 | 0.00 | 0.00 | 0.00 | 24. | 30. |
| 8 OCT 2200 | 37 | 0.09 | 0.09 | 0.00 | 0. | 3. | 10 OCT 1400 | 77 | 0.00 | 0.00 | 0.00 | 23. | 29. |
| 8 OCT 2300 | 38 | 0.00 | 0.00 | 0.00 | 0. | 4. | 10 OCT 1500 | 78 | 0.00 | 0.00 | 0.00 | 23. | 27. |
| 9 OCT 0000 | 39 | 0.00 | 0.00 | 0.00 | 0. | 3. | 10 OCT 1600 | 79 | 0.00 | 0.00 | 0.00 | 22. | 26. |
| 9 OCT 0100 | 40 | 0.09 | 0.09 | 0.00 | 0. | 4. | 10 OCT 1700 | 80 | 0.00 | 0.00 | 0.00 | 21. | 25. |

TOTAL RAINFALL = 3.19, TOTAL LOSS = 2.84, TOTAL EXCESS = 0.35

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 79.00-HR |
|---|---|---|---|---|---|---|
| 324. | 51.00 | (CFS) | 269. | 119. | 45. | 39. |
| | | (INCHES) | 0.205 | 0.362 | 0.399 | 0.390 |
| | | (AC-FT) | 133. | 235. | 251. | 254. |


STATION COREY
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS
(-) LIMITS OF OPTIMIZATION

HEC-1 INPUT 

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1       ID        COREY CREEK     5-14-78
  2       ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3       IT      60 14MAY78    0500      30
  4       IU       1       2
  5       OU       5      16
  6       PG  CANTON    3.37
  7       PG  COVING    1.96
  8       PG    TROY    1.26
  9       PG  JACSUM
 10       PI     .10     .10     .00     .10     .20     .10     .00     .00     .50     .20
 11       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 12       PI     .00     .00     .00     .00     .00     .00     .10     .00     .00     .00

 13       KK   COREY
 14       QO      13      17      23      45      86     143     183     245     451     736
 15       QO     338     672     524     398     306     254     221     200     183     171
 16       QO     169     162     151     142     136     132     136     141     133     128
 17       PT  CANTON  COVING    TROY
 18       PW     .14     .85     .01
 19       PR  JACSUM
 20       PW     1.0
 21       BA    12.2      0.
 22       BF     13.     85.  1.0335
 23       UC    1.03    6.94
 24       LU     .28     .14
 25       ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 5 THROUGH 16)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.006 | | 9.62 | | | |
| COMPUTED HYDROGRAPH | 5041. | 0.640 | 420. | 12.11 | 2.49 | 824. | 10.00 |
| OBSERVED HYDROGRAPH | 4836. | 0.614 | 403. | 11.22 | 1.60 | 838. | 10.00 |
| DIFFERENCE | 205. | 0.026 | 17. | 0.89 | 0.89 | -14. | 0.00 |
| PERCENT DIFFERENCE | 4.25 | | | | 55.58 | -1.68 | |

STANDARD ERROR 171. AVERAGE ABSOLUTE ERROR 141.
OBJECTIVE FUNCTION 178. AVERAGE PERCENT ABSOLUTE ERROR 40.86

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 30)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.006 | | 9.62 | | | |
| COMPUTED HYDROGRAPH | 7719. | 0.980 | 257. | 15.23 | 5.61 | 824. | 10.00 |
| OBSERVED HYDROGRAPH | 7141. | 0.907 | 238. | 14.71 | 5.09 | 838. | 10.00 |
| DIFFERENCE | 578. | 0.073 | 19. | 0.52 | 0.52 | -14. | 0.00 |
| PERCENT DIFFERENCE | 8.10 | | | | 10.29 | -1.68 | |

STANDARD ERROR 120. AVERAGE ABSOLUTE ERROR 84.
OBJECTIVE FUNCTION 155. AVERAGE PERCENT ABSOLUTE ERROR 37.61

UNIT HYDROGRAPH
38 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 525. | 984. | 855. | 740. | 641. | 555. | 480. | 416. | 360. | 311. |
| 270. | 233. | 202. | 175. | 151. | 131. | 113. | 98. | 85. | 74. |
| 64. | 55. | 48. | 41. | 36. | 31. | 27. | 23. | 20. | 17. |
| 15. | 13. | 11. | 10. | 8. | 7. | 6. | 5. | | |

HYDROGRAPH AT STATION COREY

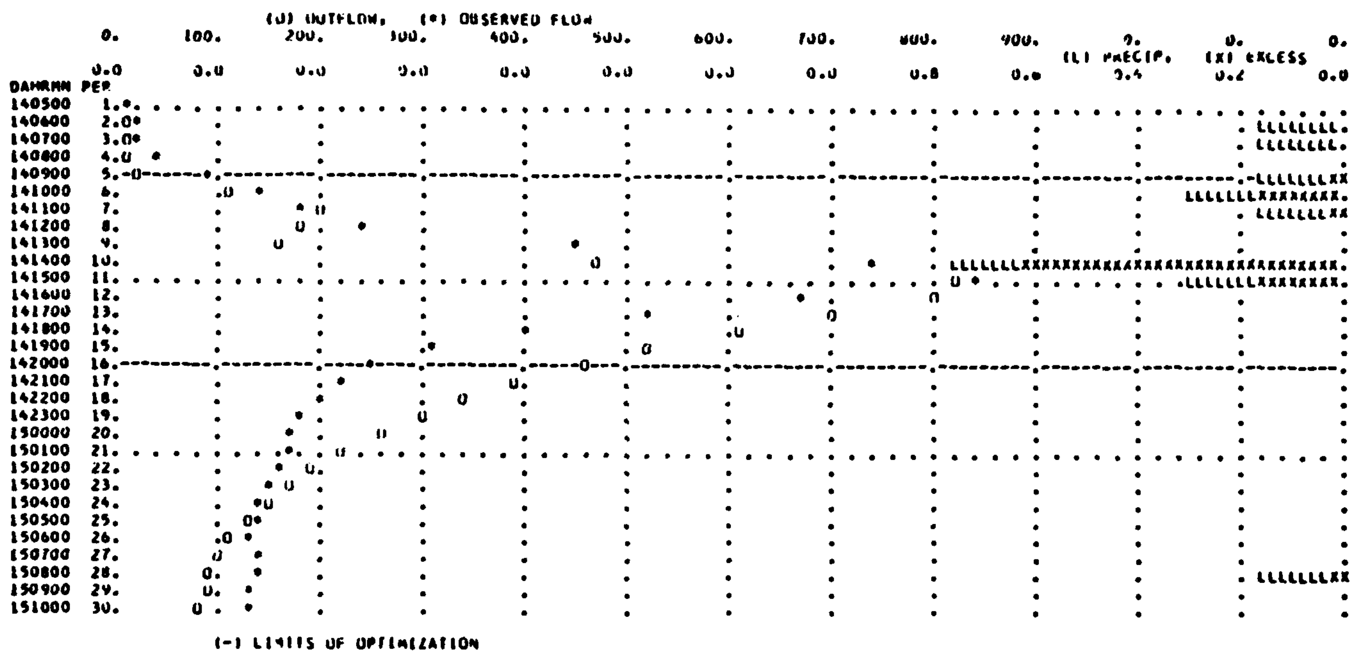
| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 MAY 0500 | 1 | 0.00 | 0.00 | 0.00 | 13. | 13. | 14 MAY 2000 | 16 | 0.00 | 0.00 | 0.00 | 455. | 294. |
| 14 MAY 0600 | 2 | 0.15 | 0.15 | 0.00 | 13. | 17. | 14 MAY 2100 | 17 | 0.00 | 0.00 | 0.00 | 395. | 221. |
| 14 MAY 0700 | 3 | 0.15 | 0.15 | 0.00 | 13. | 23. | 14 MAY 2200 | 18 | 0.00 | 0.00 | 0.00 | 342. | 200. |
| 14 MAY 0800 | 4 | 0.00 | 0.00 | 0.00 | 14. | 45. | 14 MAY 2300 | 19 | 0.00 | 0.00 | 0.00 | 297. | 183. |
| 14 MAY 0900 | 5 | 0.15 | 0.14 | 0.01 | 21. | 80. | 15 MAY 0000 | 20 | 0.00 | 0.00 | 0.00 | 258. | 171. |
| 14 MAY 1000 | 6 | 0.31 | 0.14 | 0.17 | 115. | 143. | 15 MAY 0100 | 21 | 0.00 | 0.00 | 0.00 | 224. | 169. |
| 14 MAY 1100 | 7 | 0.15 | 0.14 | 0.01 | 195. | 183. | 15 MAY 0200 | 22 | 0.00 | 0.00 | 0.00 | 195. | 162. |
| 14 MAY 1200 | 8 | 0.00 | 0.00 | 0.00 | 178. | 245. | 15 MAY 0300 | 23 | 0.00 | 0.00 | 0.00 | 169. | 151. |
| 14 MAY 1300 | 9 | 0.00 | 0.00 | 0.00 | 155. | 451. | 15 MAY 0400 | 24 | 0.00 | 0.00 | 0.00 | 147. | 142. |
| 14 MAY 1400 | 10 | 0.77 | 0.14 | 0.63 | 465. | 736. | 15 MAY 0500 | 25 | 0.00 | 0.00 | 0.00 | 128. | 136. |
| 14 MAY 1500 | 11 | 0.31 | 0.14 | 0.17 | 824. | 838. | 15 MAY 0600 | 26 | 0.00 | 0.00 | 0.00 | 111. | 132. |
| 14 MAY 1600 | 12 | 0.00 | 0.00 | 0.00 | 805. | 672. | 15 MAY 0700 | 27 | 0.00 | 0.00 | 0.00 | 97. | 136. |
| 14 MAY 1700 | 13 | 0.00 | 0.00 | 0.00 | 698. | 524. | 15 MAY 0800 | 28 | 0.15 | 0.14 | 0.01 | 92. | 141. |
| 14 MAY 1800 | 14 | 0.00 | 0.00 | 0.00 | 605. | 398. | 15 MAY 0900 | 29 | 0.00 | 0.07 | 0.00 | 87. | 135. |
| 14 MAY 1900 | 15 | 0.00 | 0.00 | 0.00 | 525. | 306. | 15 MAY 1000 | 30 | 0.00 | 0.00 | 0.00 | 83. | 128. |

TOTAL RAINFALL = 2.15, TOTAL LOSS = 1.14, TOTAL EXCESS = 1.01

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 29.00-HR |
|---|---|---|---|---|---|---|
| 824. | 10.00 | (CFS) | 653. | 314. | 265. | 265. |
| | | (INCHES) | 0.498 | 0.959 | 0.974 | 0.974 |
| | | (AC-FT) | 324. | 624. | 634. | 634. |

CUMULATIVE AREA = 12.20 SQ MI

STATION COKEY



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                                         HEC-1 INPUT                                             PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        COREY CREEK      10-05-79
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3           IT       60 05OCT79    0800       40
  4           IO        1       2
  5           DU        5      23
  6           PG  CANTCN    1.73
  7           PG  COVING    2.50
  8           PG  JACSUM
  9           PI     .10     .00     .10     .30     .20     .40     .20     .30     .30     .10
 10           PI     .10     .00     .20     .20     .00     .10     .00     .00     .00     .00

 11           KK   COREY
 12           QO       9       9       9      10      11      17      43     168     255     286
 13           QO     363     396     393     322     368     390     385     385     340     274
 14           QO     212     176     152     136     124     114     107      99      94      88
 15           QO      84      80      76      73      71      68      66      64      61      60
 16           PT  CANTCN  COVING
 17           PW     .13     .87
 18           PR  JACSUM
 19           PW     1.0
 20           BA    12.2      0.
 21           OF      7.     60.  1.0335
 22           UC     -3.     -8.
 23           LU    -.90    -.19
 24           ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 5 THROUGH 23)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.826 | | 10.08 | | | |
| COMPUTED HYDROGRAPH | 4918. | 0.625 | 259. | 15.28 | 5.19 | 404. | 11.00 |
| OBSERVED HYDROGRAPH | 4936. | 0.627 | 260. | 15.06 | 4.97 | 396. | 11.00 |
| DIFFERENCE | -18. | -0.002 | -1. | 0.22 | 0.22 | 8. | 0.00 |
| PERCENT DIFFERENCE | -0.36 | | | | 4.43 | 2.00 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 31. | AVERAGE ABSOLUTE ERROR | 25. |
| OBJECTIVE FUNCTION | 31. | AVERAGE PERCENT ABSOLUTE ERROR | 15.21 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 40)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.826 | | 10.08 | | | |
| COMPUTED HYDROGRAPH | 6499. | 0.825 | 162. | 18.70 | 8.62 | 404. | 11.00 |
| OBSERVED HYDROGRAPH | 6438. | 0.818 | 161. | 18.56 | 8.48 | 396. | 11.00 |
| DIFFERENCE | 61. | 0.008 | 2. | 0.14 | 0.14 | 8. | 0.00 |
| PERCENT DIFFERENCE | 0.95 | | | | 1.63 | 2.00 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 25. | AVERAGE ABSOLUTE ERROR | 18. |
| OBJECTIVE FUNCTION | 30. | AVERAGE PERCENT ABSOLUTE ERROR | 15.64 |

UNIT HYDROGRAPH
51 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 192. | 572. | 724. | 651. | 586. | 526. | 472. | 424. | 381. | 342. |
| 307. | 275. | 247. | 222. | 199. | 179. | 161. | 144. | 129. | 116. |
| 104. | 94. | 84. | 76. | 68. | 61. | 55. | 49. | 44. | 40. |
| 35. | 32. | 29. | 26. | 23. | 21. | 19. | 17. | 15. | 13. |
| 12. | 11. | 10. | 9. | 8. | 7. | 6. | 6. | 5. | 5. |
| 4. | | | | | | | | | |

HYDROGRAPH AT STATION COREY

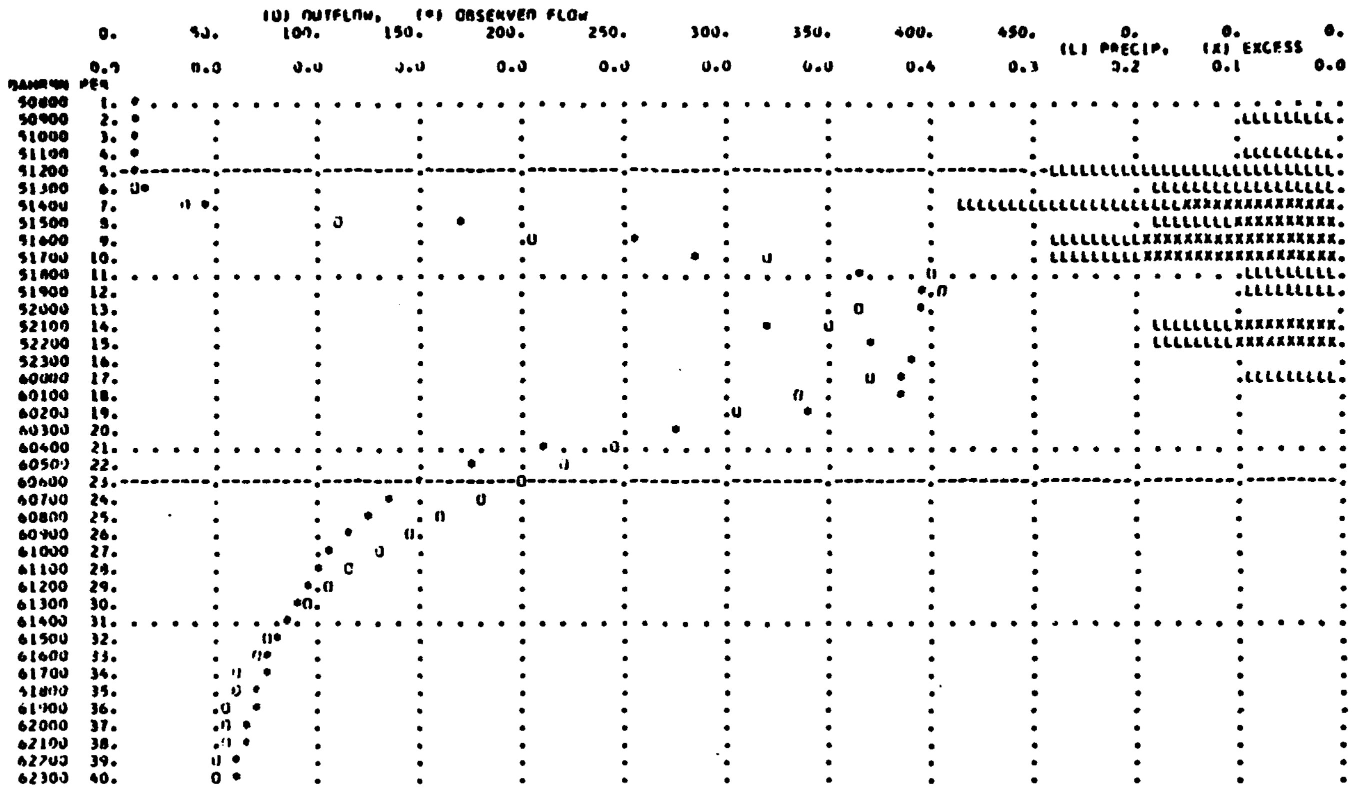
| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 OCT 0800 | 1 | 0.33 | 0.00 | 0.00 | 9. | 9. | 6 OCT 0400 | 21 | 0.00 | 0.00 | 0.00 | 245. | 212. |
| 5 OCT 0900 | 2 | 0.09 | 0.09 | 0.00 | 9. | 9. | 6 OCT 0500 | 22 | 0.00 | 0.00 | 0.00 | 220. | 176. |
| 5 OCT 1000 | 3 | 0.00 | 0.00 | 0.00 | 8. | 9. | 6 OCT 0600 | 23 | 0.00 | 0.00 | 0.00 | 198. | 152. |
| 5 OCT 1100 | 4 | 0.09 | 0.09 | 0.00 | 8. | 10. | 6 OCT 0700 | 24 | 0.00 | 0.00 | 0.00 | 178. | 136. |
| 5 OCT 1200 | 5 | 0.28 | 0.28 | 0.00 | 8. | 11. | 6 OCT 0800 | 25 | 0.00 | 0.00 | 0.00 | 160. | 124. |
| 5 OCT 1300 | 6 | 0.14 | 0.13 | 0.01 | 9. | 17. | 6 OCT 0900 | 26 | 0.00 | 0.00 | 0.00 | 144. | 114. |
| 5 OCT 1400 | 7 | 0.37 | 0.22 | 0.15 | 36. | 43. | 6 OCT 1000 | 27 | 0.00 | 0.00 | 0.00 | 130. | 107. |
| 5 OCT 1500 | 8 | 0.16 | 0.09 | 0.10 | 112. | 168. | 6 OCT 1100 | 28 | 0.00 | 0.00 | 0.00 | 117. | 99. |
| 5 OCT 1600 | 9 | 0.28 | 0.09 | 0.19 | 207. | 255. | 6 OCT 1200 | 29 | 0.00 | 0.00 | 0.00 | 105. | 94. |
| 5 OCT 1700 | 10 | 0.29 | 0.09 | 0.19 | 319. | 286. | 6 OCT 1300 | 30 | 0.00 | 0.00 | 0.00 | 95. | 88. |
| 5 OCT 1800 | 11 | 0.09 | 0.09 | 0.00 | 402. | 363. | 6 OCT 1400 | 31 | 0.00 | 0.00 | 0.00 | 85. | 84. |
| 5 OCT 1900 | 12 | 0.09 | 0.09 | 0.00 | 404. | 396. | 6 OCT 1500 | 32 | 0.00 | 0.00 | 0.00 | 77. | 80. |
| 5 OCT 2000 | 13 | 0.10 | 0.00 | 0.00 | 366. | 393. | 6 OCT 1600 | 33 | 0.00 | 0.00 | 0.00 | 69. | 76. |
| 5 OCT 2100 | 14 | 0.18 | 0.09 | 0.10 | 348. | 372. | 6 OCT 1700 | 34 | 0.00 | 0.00 | 0.00 | 62. | 73. |
| 5 OCT 2200 | 15 | 0.18 | 0.09 | 0.10 | 370. | 368. | 6 OCT 1800 | 35 | 0.00 | 0.00 | 0.00 | 59. | 71. |
| 5 OCT 2300 | 16 | 0.00 | 0.00 | 0.00 | 391. | 390. | 6 OCT 1900 | 36 | 0.00 | 0.00 | 0.00 | 57. | 68. |
| 6 OCT 0000 | 17 | 0.09 | 0.09 | 0.00 | 372. | 385. | 6 OCT 2000 | 37 | 0.00 | 0.00 | 0.00 | 55. | 66. |
| 6 OCT 0100 | 18 | 0.00 | 0.00 | 0.00 | 346. | 385. | 6 OCT 2100 | 38 | 0.00 | 0.00 | 0.00 | 53. | 64. |
| 6 OCT 0200 | 19 | 0.00 | 0.00 | 0.00 | 303. | 340. | 6 OCT 2200 | 39 | 0.00 | 0.00 | 0.00 | 51. | 61. |
| 6 OCT 0300 | 20 | 0.00 | 0.00 | 0.00 | 273. | 274. | 6 OCT 2300 | 40 | 0.00 | 0.00 | 0.00 | 50. | 60. |

TOTAL RAINFALL = 2.40, TOTAL LOSS = 1.57, TOTAL EXCESS = 0.83

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 39.00-HR |
|---|---|---|---|---|---|---|
| 434. | 11.00 | (CFS) | 374. | 244. | 166. | 166. |
| | | (INCHES) | 0.238 | 0.745 | 0.822 | 0.822 |
| | | (AC-FT) | 187. | 484. | 535. | 535. |

CUMULATIVE AREA = 12.20 SQ MI

STATION COREY




(-) LIMITS OF OPTIMIZATION

HEC-1 INPUT

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LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1          ID        COREY CREEK      11-26-79
  2          ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3          IT      60 26NOV79    0900       30
  4          IN       1        2
  5          OU       3       12
  6          PG  CANTCN     1.48
  7          PG  COVING     1.45
  8          PG  JACSUM
  9          PI      .2       .4       .0       .6       .2       .1       .1       .0       .0       .1

 10          KK   COREY
 11          QO       9       13      107      375      484      584      867      833      580      403
 12          QO     321      288      261      229      203      183      160      149      139      131
 13          QO     123      116      110      105      100       96       92       88       84       81
 14          PT  CANTCN   COVING
 15          PW     .13      .87
 16          PR  JACSUM
 17          PW     1.0
 18          BA    12.2       0.
 19          BF      9.     140.   1.0335
 20          UC     -3.      -4.
 21          LU     -.3     -.08
 22          ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 3 THROUGH 12)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.715 | | 4.52 | | | |
| COMPUTED HYDROGRAPH | 4836. | 0.614 | 484. | 7.76 | 3.24 | 878. | 6.00 |
| OBSERVED HYDROGRAPH | 4842. | 0.615 | 484. | 7.58 | 3.06 | 867. | 6.00 |
| DIFFERENCE | -6. | -0.001 | -1. | 0.17 | 0.17 | 11. | 0.00 |
| PERCENT DIFFERENCE | -0.13 | | | | 5.65 | 1.24 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 74. | AVERAGE ABSOLUTE ERROR | 58. |
| OBJECTIVE FUNCTION | 73. | AVERAGE PERCENT ABSOLUTE ERROR | 14.86 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 30)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.715 | | 4.52 | | | |
| COMPUTED HYDROGRAPH | 6975. | 0.886 | 233. | 11.56 | 7.04 | 878. | 6.00 |
| OBSERVED HYDROGRAPH | 7314. | 0.929 | 244. | 11.62 | 7.10 | 867. | 6.00 |
| DIFFERENCE | -339. | -0.043 | -11. | -0.06 | -0.06 | 11. | 0.00 |
| PERCENT DIFFERENCE | -4.63 | | | | -0.77 | 1.24 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 48. | AVERAGE ABSOLUTE ERROR | 31. |
| OBJECTIVE FUNCTION | 64. | AVERAGE PERCENT ABSOLUTE ERROR | 12.31 |

UNIT HYDROGRAPH
22 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 313. | 1321. | 1399. | 1715. | 928. | 708. | 541. | 413. | 315. | 241. |
| 184. | 141. | 107. | 82. | 62. | 48. | 36. | 28. | 21. | 16. |
| 12. | 9. | | | | | | | | |

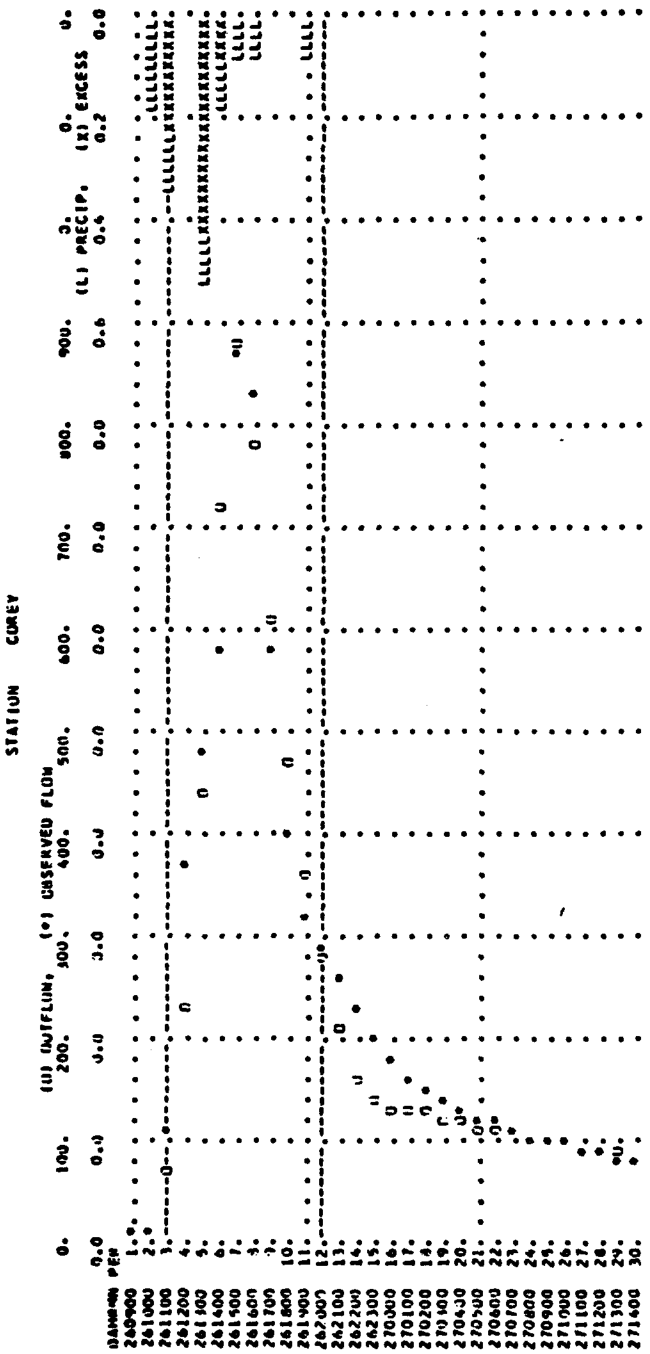
HYDROGRAPH AT STATION COKEY

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 NOV 0900 | 1 | 0.00 | 0.00 | 0.00 | 9. | 9. | 27 NOV 0000 | 16 | 0.00 | 0.00 | 0.00 | 134. | 183. |
| 26 NOV 1000 | 2 | 0.17 | 0.17 | 0.00 | 9. | 13. | 27 NOV 0100 | 17 | 0.00 | 0.00 | 0.00 | 129. | 160. |
| 26 NOV 1100 | 3 | 0.34 | 0.13 | 0.21 | 75. | 107. | 27 NOV 0200 | 18 | 0.00 | 0.00 | 0.00 | 125. | 149. |
| 26 NOV 1200 | 4 | 0.00 | 0.00 | 0.00 | 225. | 175. | 27 NOV 0300 | 19 | 0.00 | 0.00 | 0.00 | 121. | 139. |
| 26 NOV 1300 | 5 | 0.51 | 0.09 | 0.42 | 437. | 484. | 27 NOV 0400 | 20 | 0.00 | 0.00 | 0.00 | 117. | 131. |
| 26 NOV 1400 | 6 | 0.17 | 0.09 | 0.08 | 723. | 584. | 27 NOV 0500 | 21 | 0.00 | 0.00 | 0.00 | 113. | 123. |
| 26 NOV 1500 | 7 | 0.39 | 0.04 | 0.00 | 878. | 867. | 27 NOV 0600 | 22 | 0.00 | 0.00 | 0.00 | 110. | 116. |
| 26 NOV 1600 | 8 | 0.09 | 0.09 | 0.00 | 784. | 833. | 27 NOV 0700 | 23 | 0.00 | 0.00 | 0.00 | 106. | 110. |
| 26 NOV 1700 | 9 | 0.00 | 0.00 | 0.00 | 612. | 580. | 27 NOV 0800 | 24 | 0.00 | 0.00 | 0.00 | 103. | 105. |
| 26 NOV 1800 | 10 | 0.00 | 0.00 | 0.00 | 464. | 403. | 27 NOV 0900 | 25 | 0.00 | 0.00 | 0.00 | 99. | 100. |
| 26 NOV 1900 | 11 | 0.00 | 0.00 | 0.00 | 359. | 321. | 27 NOV 1000 | 26 | 0.00 | 0.00 | 0.00 | 96. | 96. |
| 26 NOV 2000 | 12 | 0.00 | 0.00 | 0.00 | 275. | 248. | 27 NOV 1100 | 27 | 0.00 | 0.00 | 0.00 | 93. | 92. |
| 26 NOV 2100 | 13 | 0.00 | 0.00 | 0.00 | 212. | 261. | 27 NOV 1200 | 28 | 0.00 | 0.00 | 0.00 | 90. | 88. |
| 26 NOV 2200 | 14 | 0.00 | 0.00 | 0.00 | 163. | 229. | 27 NOV 1300 | 29 | 0.00 | 0.00 | 0.00 | 87. | 84. |
| 26 NOV 2300 | 15 | 0.00 | 0.00 | 0.00 | 138. | 203. | 27 NOV 1400 | 30 | 0.00 | 0.00 | 0.00 | 84. | 81. |

TOTAL RAINFALL = 1.45, TOTAL LOSS = 0.74, TOTAL EXCESS = 0.72

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 29.00-HR |
|---|---|---|---|---|---|---|
| 878. | 6.00 | (CFS) | 644. | 275. | 239. | 239. |
| | | (INCHES) | 0.491 | 0.840 | 0.880 | 0.880 |
| | | (AC-FT) | 319. | 546. | 573. | 573. |

CUMULATIVE AREA = 12.20 SQ MI


STATION COREY
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS

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                                   HEC-1 INPUT                                                    PAGE  1

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1        ID        COREY CREEK     6-05-82
   2        ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
   3        IT      60  5JUN82    0700      40
   4        IO       1       2
   5        JU       1      21
   6        PG  CANTON    2.34
   7        PG  COVING    3.28
   8        PG    TROY    1.77
   9        PG  JACSUM
  10        PI     .10     .10     .20     .10     .10     .10     .10     .10     .00     .10
  11        PI     .20     .20     .00     .10     .10     .10     .00     .00     .00     .00
  12        PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
  13        PI     .00     .00     .10     .00     .00     .00     .00     .00     .00     .00

  14        KK   COREY
  15        QO      36      37      43      87     247     327     327     331     341     331
  16        QO     331     400     464     467     464     475     464     418     377     350
  17        QO     326     303     283     261     244     230     218     212     210     210
  18        QO     212     210     203     191     179     170     159     151     144     139
  19        PT  CANTON  COVING    TROY
  20        PW     .14     .85     .01
  21        PR  JACSUM
  22        PW     1.0
  23        BA    12.2      0.
  24        BF     36.    140.  1.0335
  25        UC     -3.     -8.
  26        LU    -.80    -.10
  27        ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 1 THROUGH 21)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.337 | | 10.45 | | | |
| COMPUTED HYDROGRAPH | 6704. | 0.851 | 319. | 13.36 | 2.91 | 510. | 13.00 |
| OBSERVED HYDROGRAPH | 6643. | 0.844 | 316. | 13.11 | 2.66 | 475. | 15.00 |
| DIFFERENCE | 61. | 0.008 | 3. | 0.25 | 0.25 | 35. | -2.00 |
| PERCENT DIFFERENCE | 0.91 | | | | 9.47 | 7.46 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 40. | AVERAGE ABSOLUTE ERROR | 35. |
| OBJECTIVE FUNCTION | 40. | AVERAGE PERCENT ABSOLUTE ERROR | 17.13 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 40)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.337 | | 10.45 | | | |
| COMPUTED HYDROGRAPH | 10336. | 1.313 | 258. | 18.95 | 8.50 | 510. | 13.00 |
| OBSERVED HYDROGRAPH | 10572. | 1.343 | 264. | 19.34 | 8.89 | 475. | 15.00 |
| DIFFERENCE | -236. | -0.030 | -6. | -0.39 | -0.39 | 35. | -2.00 |
| PERCENT DIFFERENCE | -2.24 | | | | -4.40 | 7.46 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 36. | AVERAGE ABSOLUTE ERROR | 32. |
| OBJECTIVE FUNCTION | 38. | AVERAGE PERCENT ABSOLUTE ERROR | 15.58 |

UNIT HYDROGRAPH
64 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 312. | 603. | 559. | 514. | 472. | 435. | 400. | 368. | 338. | 311. |
| 280. | 261. | 242. | 222. | 205. | 188. | 173. | 159. | 146. | 135. |
| 124. | 114. | 105. | 96. | 89. | 82. | 75. | 69. | 63. | 58. |
| 54. | 49. | 45. | 42. | 38. | 35. | 32. | 30. | 27. | 25. |
| 23. | 21. | 20. | 18. | 17. | 15. | 14. | 13. | 12. | 11. |
| 10. | 9. | 9. | 8. | 7. | 7. | 6. | 6. | 5. | 5. |
| 4. | 4. | 4. | 3. | | | | | | |

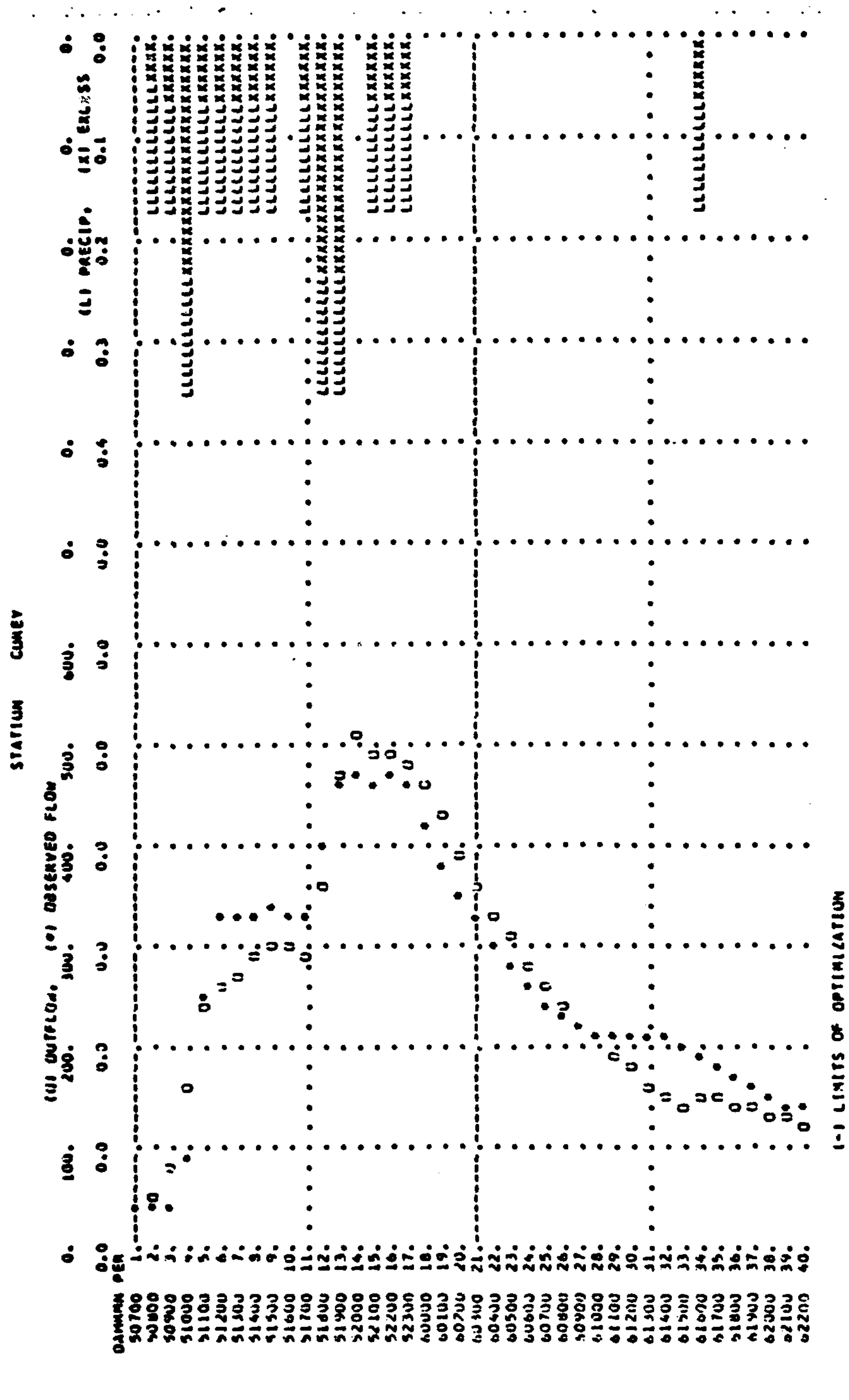
HYDROGRAPH AT STATION CUREY

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 JUN 0700 | 1 | 0.00 | 0.00 | 0.00 | 36. | 36. | 6 JUN 0300 | 21 | 0.00 | 0.00 | 0.00 | 362. | 326. |
| 5 JUN 0800 | 2 | 0.17 | 0.13 | 0.04 | 48. | 37. | 6 JUN 0400 | 22 | 0.00 | 0.00 | 0.00 | 334. | 303. |
| 5 JUN 0900 | 3 | 0.17 | 0.12 | 0.06 | 76. | 43. | 6 JUN 0500 | 23 | 0.00 | 0.00 | 0.00 | 308. | 283. |
| 5 JUN 1000 | 4 | 0.35 | 0.12 | 0.23 | 160. | 87. | 6 JUN 0600 | 24 | 0.00 | 0.00 | 0.00 | 284. | 261. |
| 5 JUN 1100 | 5 | 0.17 | 0.12 | 0.06 | 239. | 247. | 6 JUN 0700 | 25 | 0.00 | 0.00 | 0.00 | 262. | 244. |
| 5 JUN 1200 | 6 | 0.17 | 0.12 | 0.06 | 257. | 327. | 6 JUN 0800 | 26 | 0.00 | 0.00 | 0.00 | 242. | 230. |
| 5 JUN 1300 | 7 | 0.17 | 0.12 | 0.06 | 273. | 327. | 6 JUN 0900 | 27 | 0.00 | 0.00 | 0.00 | 223. | 218. |
| 5 JUN 1400 | 8 | 0.17 | 0.12 | 0.06 | 287. | 331. | 6 JUN 1000 | 28 | 0.00 | 0.00 | 0.00 | 206. | 212. |
| 5 JUN 1500 | 9 | 0.17 | 0.12 | 0.06 | 300. | 341. | 6 JUN 1100 | 29 | 0.00 | 0.00 | 0.00 | 190. | 210. |
| 5 JUN 1600 | 10 | 0.00 | 0.00 | 0.00 | 295. | 331. | 6 JUN 1200 | 30 | 0.00 | 0.00 | 0.00 | 176. | 210. |
| 5 JUN 1700 | 11 | 0.17 | 0.12 | 0.06 | 290. | 331. | 6 JUN 1300 | 31 | 0.00 | 0.00 | 0.00 | 162. | 212. |
| 5 JUN 1800 | 12 | 0.35 | 0.12 | 0.23 | 357. | 400. | 6 JUN 1400 | 32 | 0.00 | 0.00 | 0.00 | 150. | 210. |
| 5 JUN 1900 | 13 | 0.35 | 0.12 | 0.23 | 474. | 464. | 6 JUN 1500 | 33 | 0.00 | 0.00 | 0.00 | 139. | 203. |
| 5 JUN 2000 | 14 | 0.00 | 0.00 | 0.00 | 510. | 467. | 6 JUN 1600 | 34 | 0.17 | 0.12 | 0.06 | 145. | 191. |
| 5 JUN 2100 | 15 | 0.17 | 0.12 | 0.06 | 489. | 464. | 6 JUN 1700 | 35 | 0.00 | 0.00 | 0.00 | 152. | 179. |
| 5 JUN 2200 | 16 | 0.17 | 0.12 | 0.06 | 485. | 475. | 6 JUN 1800 | 36 | 0.00 | 0.00 | 0.00 | 140. | 170. |
| 5 JUN 2300 | 17 | 0.17 | 0.12 | 0.06 | 482. | 464. | 6 JUN 1900 | 37 | 0.00 | 0.00 | 0.00 | 136. | 159. |
| 6 JUN 0000 | 18 | 0.00 | 0.00 | 0.00 | 462. | 418. | 6 JUN 2000 | 38 | 0.00 | 0.00 | 0.00 | 131. | 151. |
| 6 JUN 0100 | 19 | 0.00 | 0.00 | 0.00 | 426. | 377. | 6 JUN 2100 | 39 | 0.00 | 0.00 | 0.00 | 127. | 144. |
| 6 JUN 0200 | 20 | 0.00 | 0.00 | 0.00 | 393. | 350. | 6 JUN 2200 | 40 | 0.00 | 0.00 | 0.00 | 123. | 139. |

TOTAL RAINFALL = 3.13, TOTAL LOSS = 1.80, TOTAL EXCESS = 1.34

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 39.00-HR |
|---|---|---|---|---|---|---|
| 510. | 13.00 | (CFS) | 480. | 343. | 263. | 263. |
| | | (INCHES) | 0.366 | 1.044 | 1.303 | 1.303 |
| | | (AC-FT) | 239. | 679. | 848. | 848. |

CUMULATIVE AREA = 12.20 SQ MI


STATION CUMEV
(U) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS
(-) LIMITS OF OPTIMIZATION
DAHRMN PER

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                                   HEC-1 INPUT                                               PAGE  1

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID        ELK RUN CREEK   10-22-70
  2         ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3         IT      60 21OCT70    1300      50
  4         IO       1       2
  5         OU      10      30
  6         PG    TROY    2.91
  7         PG  JACSUM
  8         PI     .05     .00     .10     .10     .10     .00     .10     .05     .05     .10
  9         PI     .00     .05     .05     .00     .20     .10     .10     .10     .20     .05
 10         PI     .05     .05     .00     .00     .00     .00     .00     .00     .00     .00

 11         KK  ELKRUN
 12         QO       3       3       3       3       3       4       4       5       6       9
 13         QO      25      48      68      81      85      95     121     200     289     320
 14         QO     278     210     180     177     158     131     108      95      89      87
 15         QO      85      76      71      65      59      56      54      51      48      46
 16         QO      44      43      41      40      39      38      37      36      35      34
 17         PT    TROY
 18         PW      1.
 19         PR  JACSUM
 20         PW     1.0
 21         BA    10.2      0.
 22         BF      3.     45.  1.0327
 23         UC     -1.     -1.
 24         LU     -1.     -1.
 25         ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 10 THROUGH 30)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.491 | | 18.00 | | | |
| COMPUTED HYDROGRAPH | 2853. | 0.433 | 136. | 22.09 | 4.09 | 347. | 20.00 |
| OBSERVED HYDROGRAPH | 2854. | 0.434 | 136. | 21.12 | 3.12 | 320. | 19.00 |
| DIFFERENCE | -1. | -0.000 | -0. | 0.97 | 0.97 | 27. | 1.00 |
| PERCENT DIFFERENCE | -0.05 | | | | 31.13 | 8.38 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 52. | AVERAGE ABSOLUTE ERROR | 42. |
| OBJECTIVE FUNCTION | 55. | AVERAGE PERCENT ABSOLUTE ERROR | 41.91 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 50)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.491 | | 18.00 | | | |
| COMPUTED HYDROGRAPH | 3631. | 0.552 | 73. | 25.52 | 7.52 | 347. | 20.00 |
| OBSERVED HYDROGRAPH | 3886. | 0.590 | 78. | 25.56 | 7.56 | 320. | 19.00 |
| DIFFERENCE | -255. | -0.039 | -5. | -0.04 | -0.04 | 27. | 1.00 |
| PERCENT DIFFERENCE | -6.57 | | | | -0.57 | 8.38 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 35. | AVERAGE ABSOLUTE ERROR | 22. |
| OBJECTIVE FUNCTION | 48. | AVERAGE PERCENT ABSOLUTE ERROR | 33.04 |

UNIT HYDROGRAPH
32 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 494. | 931. | 799. | 675. | 571. | 482. | 407. | 344. | 291. | 246. |
| 208. | 175. | 148. | 125. | 106. | 89. | 75. | 64. | 54. | 46. |
| 38. | 33. | 27. | 23. | 20. | 17. | 14. | 12. | 10. | 8. |
| 7. | 6. | | | | | | | | |

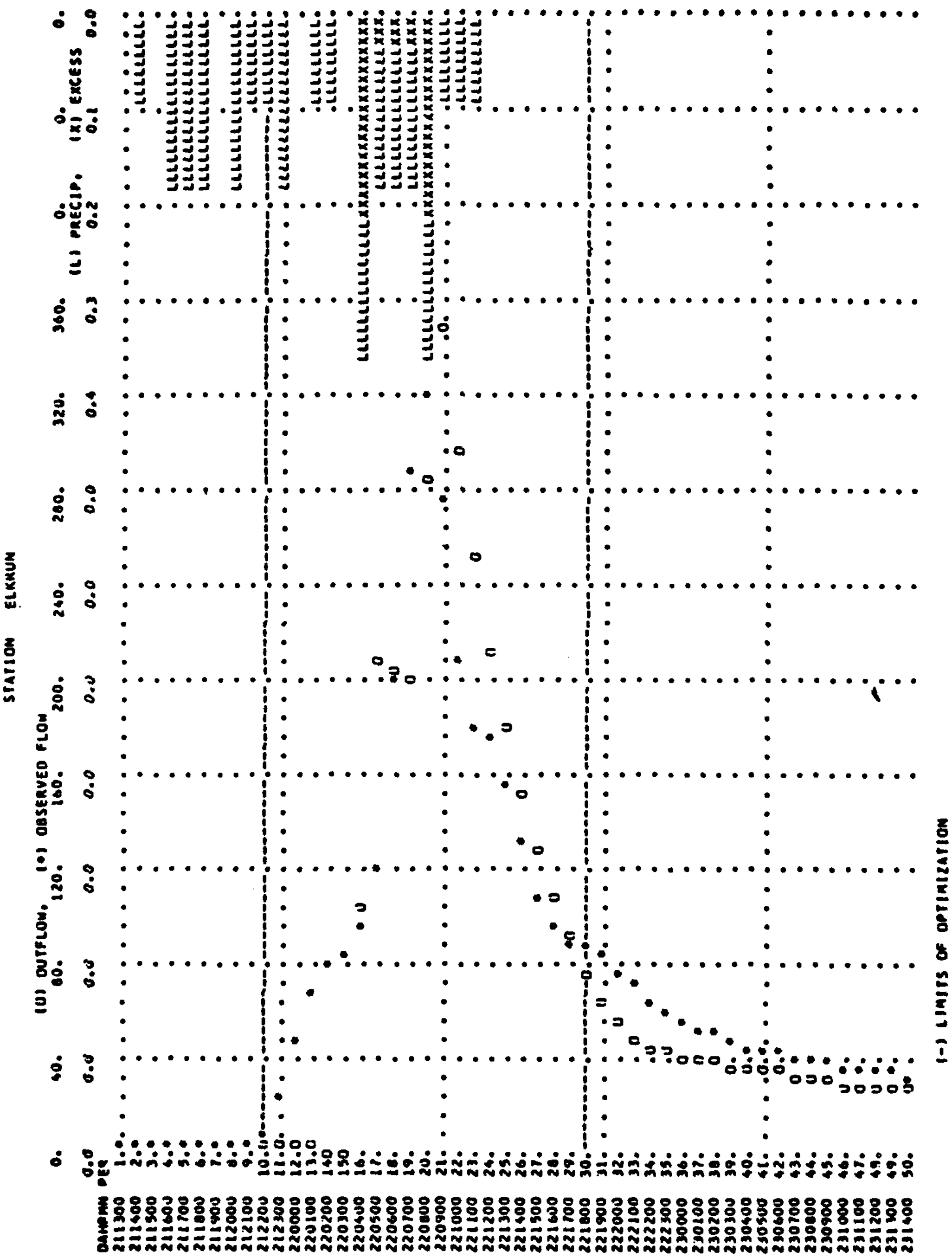
HYDROGRAPH AT STATION ELKRUN

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 OCT 1300 | 1 | 0.00 | 0.00 | 0.00 | 3. | 3. | 22 OCT 1400 | 26 | 0.00 | 0.00 | 0.00 | 151. | 131. |
| 21 OCT 1400 | 2 | 0.09 | 0.09 | 0.00 | 3. | 3. | 22 OCT 1500 | 27 | 0.00 | 0.00 | 0.00 | 128. | 108. |
| 21 OCT 1500 | 3 | 0.00 | 0.00 | 0.00 | 3. | 3. | 22 OCT 1600 | 28 | 0.00 | 0.00 | 0.00 | 108. | 95. |
| 21 OCT 1600 | 4 | 0.18 | 0.18 | 0.00 | 3. | 3. | 22 OCT 1700 | 29 | 0.00 | 0.00 | 0.00 | 92. | 89. |
| 21 OCT 1700 | 5 | 0.18 | 0.18 | 0.00 | 3. | 3. | 22 OCT 1800 | 30 | 0.00 | 0.00 | 0.00 | 78. | 87. |
| 21 OCT 1800 | 6 | 0.18 | 0.18 | 0.00 | 3. | 4. | 22 OCT 1900 | 31 | 0.00 | 0.00 | 0.00 | 66. | 85. |
| 21 OCT 1900 | 7 | 0.00 | 0.00 | 0.00 | 2. | 4. | 22 OCT 2000 | 32 | 0.00 | 0.00 | 0.00 | 56. | 76. |
| 21 OCT 2000 | 8 | 0.18 | 0.18 | 0.00 | 2. | 5. | 22 OCT 2100 | 33 | 0.00 | 0.00 | 0.00 | 47. | 71. |
| 21 OCT 2100 | 9 | 0.09 | 0.09 | 0.00 | 2. | 6. | 22 OCT 2200 | 34 | 0.00 | 0.00 | 0.00 | 44. | 65. |
| 21 OCT 2200 | 10 | 0.09 | 0.09 | 0.00 | 2. | 9. | 22 OCT 2300 | 35 | 0.00 | 0.00 | 0.00 | 43. | 59. |
| 21 OCT 2300 | 11 | 0.18 | 0.18 | 0.00 | 2. | 25. | 23 OCT 0000 | 36 | 0.00 | 0.00 | 0.00 | 41. | 56. |
| 22 OCT 0000 | 12 | 0.00 | 0.00 | 0.00 | 2. | 48. | 23 OCT 0100 | 37 | 0.00 | 0.00 | 0.00 | 40. | 54. |
| 22 OCT 0100 | 13 | 0.09 | 0.09 | 0.00 | 2. | 68. | 23 OCT 0200 | 38 | 0.00 | 0.00 | 0.00 | 39. | 51. |
| 22 OCT 0200 | 14 | 0.09 | 0.09 | 0.00 | 2. | 81. | 23 OCT 0300 | 39 | 0.00 | 0.00 | 0.00 | 37. | 48. |
| 22 OCT 0300 | 15 | 0.00 | 0.00 | 0.00 | 2. | 85. | 23 OCT 0400 | 40 | 0.00 | 0.00 | 0.00 | 36. | 46. |
| 22 OCT 0400 | 16 | 0.36 | 0.16 | 0.21 | 105. | 95. | 23 OCT 0500 | 41 | 0.00 | 0.00 | 0.00 | 35. | 44. |
| 22 OCT 0500 | 17 | 0.18 | 0.16 | 0.03 | 208. | 121. | 23 OCT 0600 | 42 | 0.00 | 0.00 | 0.00 | 34. | 43. |
| 22 OCT 0600 | 18 | 0.18 | 0.16 | 0.03 | 204. | 200. | 23 OCT 0700 | 43 | 0.00 | 0.00 | 0.00 | 33. | 41. |
| 22 OCT 0700 | 19 | 0.18 | 0.16 | 0.03 | 199. | 289. | 23 OCT 0800 | 44 | 0.00 | 0.00 | 0.00 | 32. | 40. |
| 22 OCT 0800 | 20 | 0.36 | 0.16 | 0.21 | 285. | 320. | 23 OCT 0900 | 45 | 0.00 | 0.00 | 0.00 | 31. | 39. |
| 22 OCT 0900 | 21 | 0.09 | 0.09 | 0.00 | 347. | 278. | 23 OCT 1000 | 46 | 0.00 | 0.00 | 0.00 | 30. | 38. |
| 22 OCT 1000 | 22 | 0.09 | 0.09 | 0.00 | 296. | 210. | 23 OCT 1100 | 47 | 0.00 | 0.00 | 0.00 | 29. | 37. |
| 22 OCT 1100 | 23 | 0.09 | 0.09 | 0.00 | 250. | 180. | 23 OCT 1200 | 48 | 0.00 | 0.00 | 0.00 | 28. | 36. |
| 22 OCT 1200 | 24 | 0.00 | 0.00 | 0.00 | 212. | 177. | 23 OCT 1300 | 49 | 0.00 | 0.00 | 0.00 | 27. | 35. |
| 22 OCT 1300 | 25 | 0.00 | 0.00 | 0.00 | 179. | 158. | 23 OCT 1400 | 50 | 0.00 | 0.00 | 0.00 | 26. | 34. |

TOTAL RAINFALL = 2.91, TOTAL LOSS = 2.42, TOTAL EXCESS = 0.49

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 49.00-HR |
|---|---|---|---|---|---|---|
| 347. | 20.00 | (CFS) | 264. | 135. | 74. | 74. |
| | | (INCHES) | 0.241 | 0.491 | 0.549 | 0.549 |
| | | (AC-FT) | 131. | 267. | 299. | 299. |

CUMULATIVE AREA = 10.20 SQ MI


STATION ELKRUN
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS
(-) LIMITS OF OPTIMIZATION

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                                        HEC-1 INPUT                                          PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        ELK RUN CREEK    11-14-72
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3           IT      60 13NOV72    1900      45
  4           IO       1       2
  5           QU       8      25
  6           PG    TROY    2.06
  7           PG  JACSUM
  8           PI     .00     .02     .05     .03     .00     .01     .04     .05     .15     .15
  9           PI     .02     .13     .15     .20     .10     .10     .05     .05     .00     .00
 10           PI     .00     .00     .01     .00     .00     .00     .01     .01     .02     .02
 11           PI     .02     .01     .00     .00     .01     .00     .00     .00     .00     .00

 12           KK  ELKRUN
 13           QO       6       6       6       7       7       7       8      13      19      34
 14           QO      67     100     126     177     204     216     207     233     216     179
 15           QO     154     124     107      98      92      89      87      85      83      81
 16           QO      79      75      71      67      63      61      60      57      55      53
 17           QO      51      50      48      47      46       0       0       0       0       0
 18           PT    TROY
 19           PW      1.
 20           PR  JACSUM
 21           PW     1.0
 22           BA    10.2      0.
 23           BF      6.     50.  1.0327
 24           UC     -3.     -6.
 25           LU     -.4    -.12
 26           ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 8 THROUGH 25)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.465 | | 13.09 | | | |
| COMPUTED HYDROGRAPH | 2366. | 0.359 | 131. | 17.82 | 4.73 | 247. | 15.00 |
| OBSERVED HYDROGRAPH | 2366. | 0.359 | 131. | 17.61 | 4.52 | 233. | 17.00 |
| DIFFERENCE | 0. | 0.000 | 0. | 0.21 | 0.21 | 14. | -2.00 |
| PERCENT DIFFERENCE | 0.00 | | | | 4.69 | 5.92 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 17. | AVERAGE ABSOLUTE ERROR | 13. |
| OBJECTIVE FUNCTION | 18. | AVERAGE PERCENT ABSOLUTE ERROR | 16.62 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 45)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.465 | | 13.09 | | | |
| COMPUTED HYDROGRAPH | 3355. | 0.510 | 75. | 22.21 | 9.12 | 247. | 15.00 |
| OBSERVED HYDROGRAPH | 3721. | 0.565 | 83. | 23.29 | 10.20 | 233. | 17.00 |
| DIFFERENCE | -366. | -0.056 | -8. | -1.08 | -1.08 | 14. | -2.00 |
| PERCENT DIFFERENCE | -9.83 | | | | -10.58 | 5.92 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 16. | AVERAGE ABSOLUTE ERROR | 13. |
| OBJECTIVE FUNCTION | 19. | AVERAGE PERCENT ABSOLUTE ERROR | 22.71 |

UNIT HYDROGRAPH
45 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 265. | 601. | 633. | 543. | 500. | 445. | 396. | 352. | 313. | 278. |
| 249. | 220. | 196. | 174. | 155. | 138. | 122. | 109. | 97. | 86. |
| 77. | 68. | 61. | 54. | 48. | 43. | 38. | 34. | 30. | 27. |
| 24. | 21. | 19. | 17. | 15. | 13. | 12. | 10. | 9. | 8. |
| 7. | 7. | 6. | 5. | 5. | 4. | | | | |

HYDROGRAPH AT STATION ELKRUN

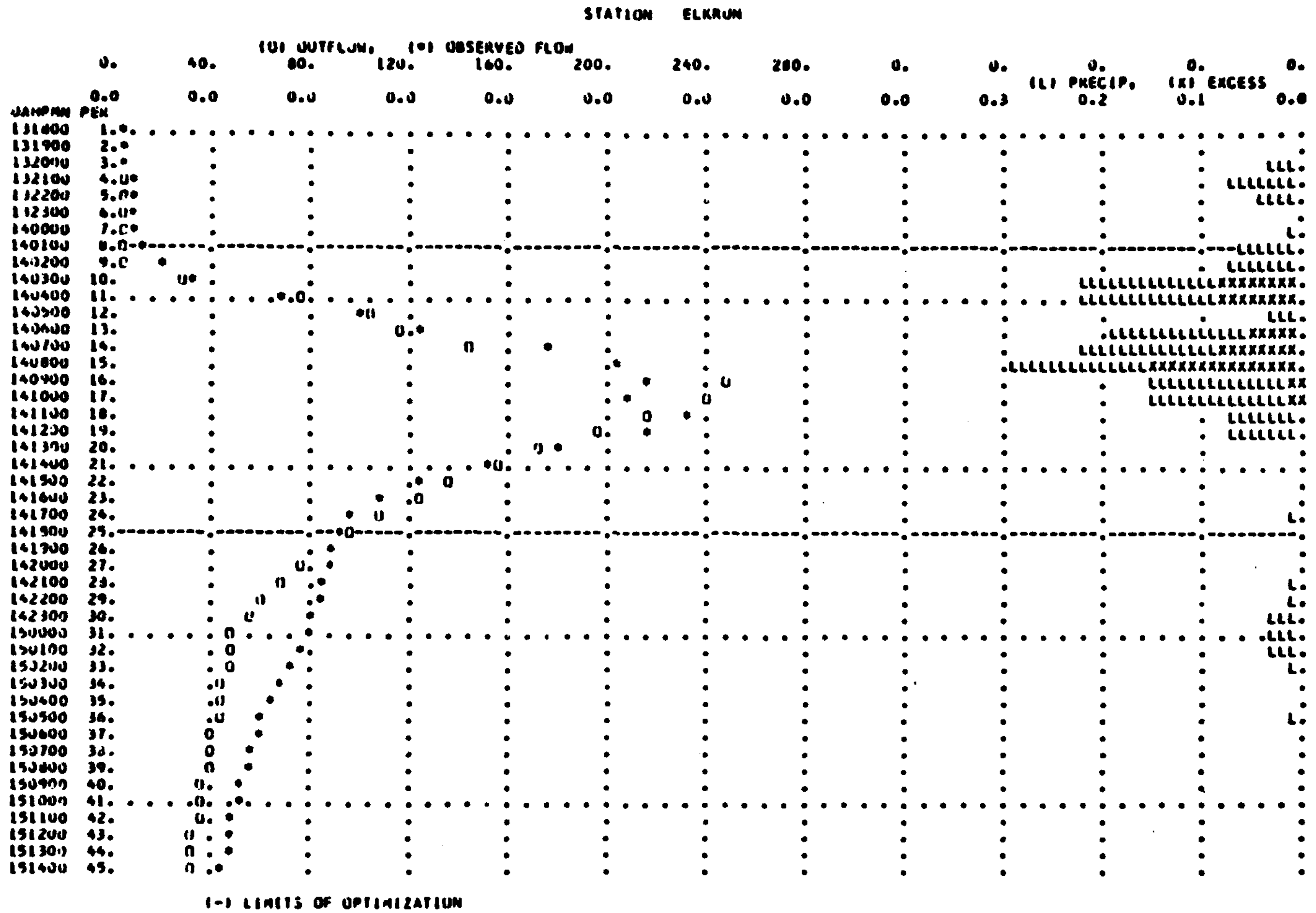
| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 13 NOV 1800 | 1 | 0.00 | 0.00 | 0.00 | 6. | 6. |
| 13 NOV 1900 | 2 | 0.00 | 0.00 | 0.00 | 6. | 6. |
| 13 NOV 2000 | 3 | 0.03 | 0.03 | 0.00 | 6. | 6. |
| 13 NOV 2100 | 4 | 0.07 | 0.07 | 0.00 | 5. | 7. |
| 13 NOV 2200 | 5 | 0.04 | 0.04 | 0.00 | 5. | 7. |
| 13 NOV 2300 | 6 | 0.00 | 0.00 | 0.00 | 5. | 7. |
| 14 NOV 0000 | 7 | 0.01 | 0.01 | 0.00 | 5. | 8. |
| 14 NOV 0100 | 8 | 0.06 | 0.06 | 0.00 | 5. | 13. |
| 14 NOV 0200 | 9 | 0.07 | 0.07 | 0.00 | 5. | 19. |
| 14 NOV 0300 | 10 | 0.22 | 0.14 | 0.08 | 26. | 34. |
| 14 NOV 0400 | 11 | 0.22 | 0.14 | 0.08 | 75. | 67. |
| 14 NOV 0500 | 12 | 0.03 | 0.03 | 0.00 | 104. | 100. |
| 14 NOV 0600 | 13 | 0.19 | 0.14 | 0.05 | 115. | 126. |
| 14 NOV 0700 | 14 | 0.22 | 0.14 | 0.09 | 143. | 177. |
| 14 NOV 0800 | 15 | 0.29 | 0.14 | 0.15 | 203. | 204. |
| 14 NOV 0900 | 16 | 0.15 | 0.14 | 0.01 | 247. | 216. |
| 14 NOV 1000 | 17 | 0.15 | 0.14 | 0.01 | 240. | 207. |
| 14 NOV 1100 | 18 | 0.07 | 0.07 | 0.00 | 217. | 233. |
| 14 NOV 1200 | 19 | 0.07 | 0.07 | 0.00 | 194. | 216. |
| 14 NOV 1300 | 20 | 0.00 | 0.00 | 0.00 | 173. | 174. |
| 14 NOV 1400 | 21 | 0.00 | 0.00 | 0.00 | 154. | 154. |
| 14 NOV 1500 | 22 | 0.00 | 0.00 | 0.00 | 137. | 124. |
| 14 NOV 1600 | 23 | 0.00 | 0.00 | 0.00 | 122. | 107. |

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 14 NOV 1700 | 24 | 0.01 | 0.01 | 0.00 | 109. | 98. |
| 14 NOV 1800 | 25 | 0.00 | 0.00 | 0.00 | 97. | 92. |
| 14 NOV 1900 | 26 | 0.00 | 0.00 | 0.00 | 87. | 89. |
| 14 NOV 2000 | 27 | 0.00 | 0.00 | 0.00 | 77. | 87. |
| 14 NOV 2100 | 28 | 0.01 | 0.01 | 0.00 | 69. | 85. |
| 14 NOV 2200 | 29 | 0.01 | 0.01 | 0.00 | 62. | 83. |
| 14 NOV 2300 | 30 | 0.03 | 0.03 | 0.00 | 55. | 81. |
| 15 NOV 0000 | 31 | 0.03 | 0.03 | 0.00 | 50. | 79. |
| 15 NOV 0100 | 32 | 0.03 | 0.03 | 0.00 | 48. | 75. |
| 15 NOV 0200 | 33 | 0.01 | 0.01 | 0.00 | 47. | 71. |
| 15 NOV 0300 | 34 | 0.00 | 0.00 | 0.00 | 45. | 67. |
| 15 NOV 0400 | 35 | 0.00 | 0.00 | 0.00 | 44. | 63. |
| 15 NOV 0500 | 36 | 0.01 | 0.01 | 0.00 | 42. | 61. |
| 15 NOV 0600 | 37 | 0.00 | 0.00 | 0.00 | 41. | 60. |
| 15 NOV 0700 | 38 | 0.00 | 0.00 | 0.00 | 40. | 57. |
| 15 NOV 0800 | 39 | 0.00 | 0.00 | 0.00 | 38. | 55. |
| 15 NOV 0900 | 40 | 0.00 | 0.00 | 0.00 | 37. | 53. |
| 15 NOV 1000 | 41 | 0.00 | 0.00 | 0.00 | 36. | 51. |
| 15 NOV 1100 | 42 | 0.00 | 0.00 | 0.00 | 35. | 50. |
| 15 NOV 1200 | 43 | 0.00 | 0.00 | 0.00 | 34. | 48. |
| 15 NOV 1300 | 44 | 0.00 | 0.00 | 0.00 | 33. | 47. |
| 15 NOV 1400 | 45 | 0.00 | 0.00 | 0.00 | 32. | 46. |

TOTAL RAINFALL = 2.06, TOTAL LOSS = 1.60, TOTAL EXCESS = 0.46

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 44.00-HR |
|---|---|---|---|---|---|---|
| 247. | 15.00 | (CFS) | 210. | 119. | 76. | 76. |
| | | (INCHES) | 0.191 | 0.435 | 0.507 | 0.507 |
| | | (AC-FT) | 104. | 236. | 276. | 276. |

CUMULATIVE AREA = 10.20 SQ MI


STATION ELKRUN
(U) OUTFLOW, (*) OBSERVED FLOW
0. 40. 80. 120. 160. 200. 240. 280. 0. 0. 0. 0. 0.
(L) PRECIP, (X) EXCESS
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.3 0.2 0.1 0.0
JAHPMN PER
131800 131900 132000 132100 132200 132300 140000 140100 140200 140300 140400 140500 140600 140700 140800 140900 141000 141100 141200 141300 141400 141500 141600 141700 141800 141900 142000 142100 142200 142300 150000 150100 150200 150300 150400 150500 150600 150700 150800 150900 151000 151100 151200 151300 151400
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45.
(-) LIMITS OF OPTIMIZATION

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1      ID        ELK RUN CREEK    9-26-75
   2      ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
   3      IT      60 24SEP75    0300      90
   4      IO       1       2
   5      OU       6      56
   6      PG    TROY    6.96
   7      PG  JACSUM
   8      PI     .10     .10     .20     .10     .20     .10     .00     .00     .00     .00
   9      PI     .00     .00     .00     .10     .00     .00     .00     .00     .00     .10
  10      PI     .00     .10     .00     .00     .10     .10     .20     .20     .10     .30
  11      PI     .00     .10     .10     .00     .00     .10     .00     .10     .20     .10
  12      PI     .10     .00     .00     .00     .40     .30     .50     .30     .50     .40
  13      PI     .10     .20     .10     .10     .10     .00     .00     .00     .00     .00

  14      KK  ELKRUN
  15      QO       2       3       3       4       6      18      45      56      53      45
  16      QO      38      33      29      26      23      22      18      17      17      17
  17      QO      17      18      27      35      42      44      45      58     223     401
  18      QO     446     380     342     322     254     194     160     141     200     310
  19      QO     371     334     276     223     204     307     648    1502    1740    1655
  20      QO    1610    1700    1457    1214    1040     900     744     550     442     367
  21      QO     322     280     247     219     200     188     171     163     152     141
  22      QO     134     126     119     114     107     103      98      94      89      85
  23      QO      81      79      77      73      71      69      67      65      63      62
  24      PT    TROY
  25      PW      1.
  26      PR  JACSUM
  27      PW     1.0
  28      BA    10.2      0.
  29      BF      2.     85.  1.0327
  30      UC     -1.     -1.
  31      LU     -1.     -1.
  32      ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 6 THROUGH 56)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.358 | | 44.03 | | | |
| COMPUTED HYDROGRAPH | 19221. | 2.920 | 377. | 45.85 | 1.82 | 1886. | 50.00 |
| OBSERVED HYDROGRAPH | 19297. | 2.932 | 378. | 46.24 | 2.21 | 1740. | 48.00 |
| DIFFERENCE | -76. | -0.012 | -1. | -0.39 | -0.39 | 146. | 2.00 |
| PERCENT DIFFERENCE | -0.39 | | | | -17.73 | 8.37 | |

STANDARD ERROR 98. AVERAGE ABSOLUTE ERROR 57.
OBJECTIVE FUNCTION 145. AVERAGE PERCENT ABSOLUTE ERROR 28.15

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 90)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.358 | | 44.03 | | | |
| COMPUTED HYDROGRAPH | 23405. | 3.556 | 260. | 49.31 | 5.28 | 1886. | 50.00 |
| OBSERVED HYDROGRAPH | 25277. | 3.840 | 281. | 51.04 | 7.01 | 1740. | 48.00 |
| DIFFERENCE | -1872. | -0.284 | -21. | -1.73 | -1.73 | 146. | 2.00 |
| PERCENT DIFFERENCE | -7.41 | | | | -24.67 | 8.37 | |

STANDARD ERROR 82. AVERAGE ABSOLUTE ERROR 52.
OBJECTIVE FUNCTION 131. AVERAGE PERCENT ABSOLUTE ERROR 31.85

UNIT HYDROGRAPH
23 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 708. | 1268. | 998. | 782. | 612. | 480. | 376. | 294. | 231. | 181. |
| 142. | 111. | 87. | 68. | 53. | 42. | 33. | 26. | 20. | 16. |
| 12. | 10. | 8. | | | | | | | |

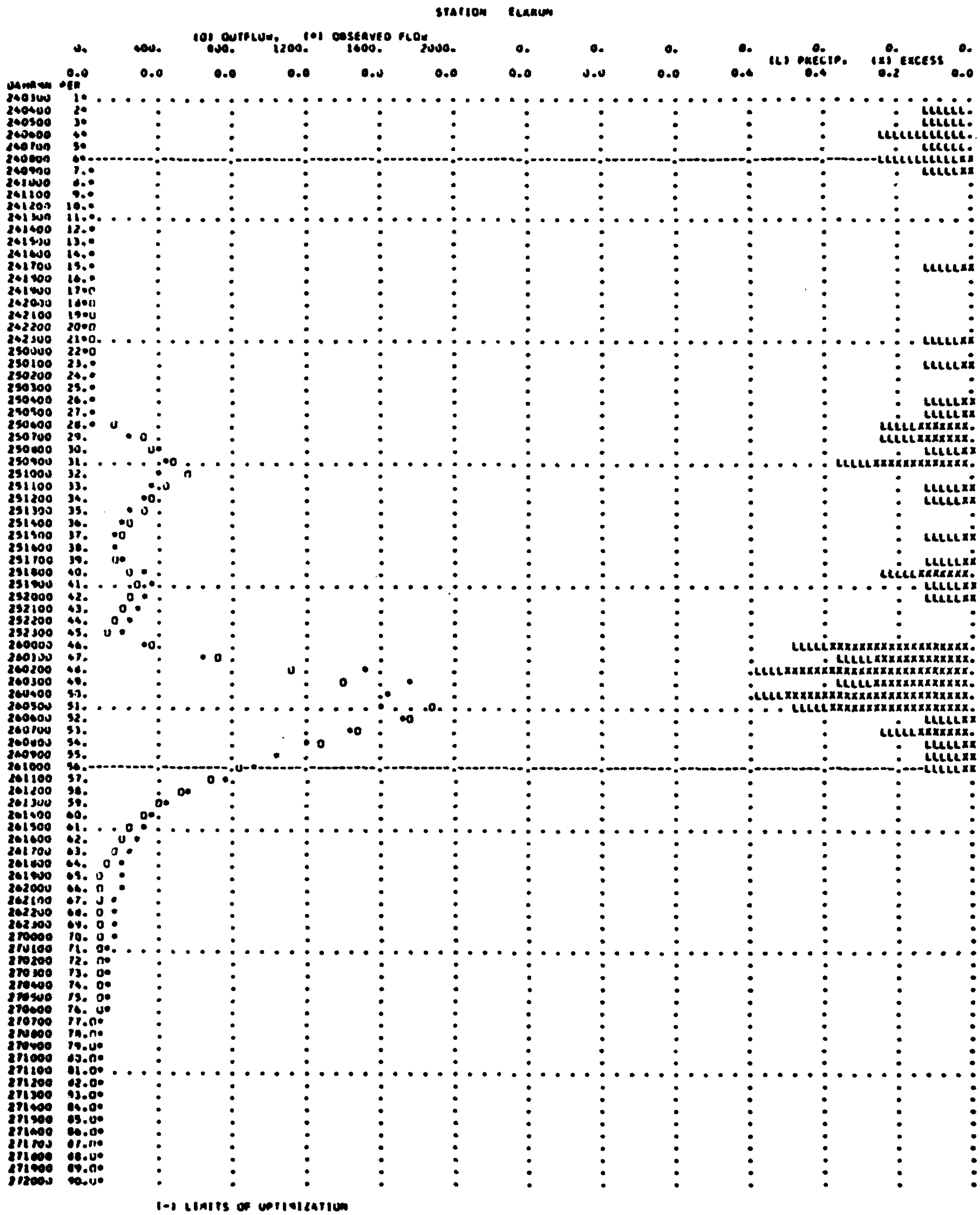
HYDROGRAPH AT STATION CLARUN

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 SEP 0300 | 1 | 0.00 | 0.00 | 0.00 | 2. | 2. | 26 SEP 0000 | 46 | 0.47 | 0.10 | 0.37 | 365. | 307. |
| 24 SEP 0400 | 2 | 0.12 | 0.12 | 0.00 | 2. | 3. | 26 SEP 0100 | 47 | 0.35 | 0.10 | 0.25 | 731. | 648. |
| 24 SEP 0500 | 3 | 0.12 | 0.12 | 0.00 | 2. | 4. | 26 SEP 0200 | 48 | 0.59 | 0.10 | 0.49 | 1103. | 1502. |
| 24 SEP 0600 | 4 | 0.24 | 0.24 | 0.00 | 2. | 4. | 26 SEP 0300 | 49 | 0.35 | 0.10 | 0.25 | 1395. | 1740. |
| 24 SEP 0700 | 5 | 0.12 | 0.12 | 0.00 | 2. | 6. | 26 SEP 0400 | 50 | 0.59 | 0.10 | 0.49 | 1624. | 1655. |
| 24 SEP 0800 | 6 | 0.24 | 0.22 | 0.01 | 10. | 18. | 26 SEP 0500 | 51 | 0.47 | 0.10 | 0.37 | 1886. | 1610. |
| 24 SEP 0900 | 7 | 0.12 | 0.10 | 0.02 | 30. | 45. | 26 SEP 0600 | 52 | 0.12 | 0.10 | 0.02 | 1757. | 1700. |
| 24 SEP 1000 | 8 | 0.00 | 0.00 | 0.00 | 37. | 56. | 26 SEP 0700 | 53 | 0.24 | 0.10 | 0.14 | 1488. | 1457. |
| 24 SEP 1100 | 9 | 0.00 | 0.00 | 0.00 | 36. | 53. | 26 SEP 0800 | 54 | 0.12 | 0.10 | 0.02 | 1275. | 1214. |
| 24 SEP 1200 | 10 | 0.00 | 0.00 | 0.00 | 35. | 45. | 26 SEP 0900 | 55 | 0.12 | 0.10 | 0.02 | 1025. | 1040. |
| 24 SEP 1300 | 11 | 0.00 | 0.00 | 0.00 | 34. | 38. | 26 SEP 1000 | 56 | 0.12 | 0.10 | 0.02 | 829. | 900. |
| 24 SEP 1400 | 12 | 0.00 | 0.00 | 0.00 | 33. | 33. | 26 SEP 1100 | 57 | 0.00 | 0.00 | 0.00 | 663. | 744. |
| 24 SEP 1500 | 13 | 0.00 | 0.00 | 0.00 | 32. | 29. | 26 SEP 1200 | 58 | 0.00 | 0.00 | 0.00 | 519. | 550. |
| 24 SEP 1600 | 14 | 0.00 | 0.00 | 0.00 | 31. | 26. | 26 SEP 1300 | 59 | 0.00 | 0.00 | 0.00 | 407. | 442. |
| 24 SEP 1700 | 15 | 0.12 | 0.10 | 0.02 | 30. | 23. | 26 SEP 1400 | 60 | 0.00 | 0.00 | 0.00 | 319. | 367. |
| 24 SEP 1800 | 16 | 0.00 | 0.00 | 0.00 | 30. | 22. | 26 SEP 1500 | 61 | 0.00 | 0.00 | 0.00 | 250. | 322. |
| 24 SEP 1900 | 17 | 0.00 | 0.00 | 0.00 | 29. | 18. | 26 SEP 1600 | 62 | 0.00 | 0.00 | 0.00 | 196. | 280. |
| 24 SEP 2000 | 18 | 0.00 | 0.00 | 0.00 | 28. | 17. | 26 SEP 1700 | 63 | 0.00 | 0.00 | 0.00 | 152. | 247. |
| 24 SEP 2100 | 19 | 0.00 | 0.00 | 0.00 | 27. | 17. | 26 SEP 1800 | 64 | 0.00 | 0.00 | 0.00 | 119. | 219. |
| 24 SEP 2200 | 20 | 0.00 | 0.00 | 0.00 | 26. | 17. | 26 SEP 1900 | 65 | 0.00 | 0.00 | 0.00 | 93. | 200. |
| 24 SEP 2300 | 21 | 0.12 | 0.10 | 0.02 | 25. | 17. | 26 SEP 2000 | 66 | 0.00 | 0.00 | 0.00 | 83. | 188. |
| 25 SEP 0000 | 22 | 0.00 | 0.00 | 0.00 | 31. | 18. | 26 SEP 2100 | 67 | 0.00 | 0.00 | 0.00 | 81. | 171. |
| 25 SEP 0100 | 23 | 0.12 | 0.10 | 0.02 | 37. | 27. | 26 SEP 2200 | 68 | 0.00 | 0.00 | 0.00 | 78. | 163. |
| 25 SEP 0200 | 24 | 0.00 | 0.00 | 0.00 | 43. | 35. | 26 SEP 2300 | 69 | 0.00 | 0.00 | 0.00 | 76. | 152. |
| 25 SEP 0300 | 25 | 0.00 | 0.00 | 0.00 | 41. | 42. | 27 SEP 0000 | 70 | 0.00 | 0.00 | 0.00 | 73. | 141. |
| 25 SEP 0400 | 26 | 0.12 | 0.10 | 0.02 | 40. | 44. | 27 SEP 0100 | 71 | 0.00 | 0.00 | 0.00 | 71. | 134. |
| 25 SEP 0500 | 27 | 0.12 | 0.10 | 0.02 | 57. | 45. | 27 SEP 0200 | 72 | 0.00 | 0.00 | 0.00 | 69. | 126. |
| 25 SEP 0600 | 28 | 0.24 | 0.10 | 0.14 | 155. | 58. | 27 SEP 0300 | 73 | 0.00 | 0.00 | 0.00 | 67. | 119. |
| 25 SEP 0700 | 29 | 0.24 | 0.10 | 0.14 | 315. | 223. | 27 SEP 0400 | 74 | 0.00 | 0.00 | 0.00 | 64. | 114. |
| 25 SEP 0800 | 30 | 0.12 | 0.10 | 0.02 | 358. | 401. | 27 SEP 0500 | 75 | 0.00 | 0.00 | 0.00 | 62. | 107. |
| 25 SEP 0900 | 31 | 0.35 | 0.10 | 0.25 | 474. | 446. | 27 SEP 0600 | 76 | 0.00 | 0.00 | 0.00 | 60. | 103. |
| 25 SEP 1000 | 32 | 0.00 | 0.00 | 0.00 | 553. | 393. | 27 SEP 0700 | 77 | 0.00 | 0.00 | 0.00 | 59. | 98. |
| 25 SEP 1100 | 33 | 0.12 | 0.10 | 0.02 | 448. | 342. | 27 SEP 0800 | 78 | 0.00 | 0.00 | 0.00 | 57. | 94. |
| 25 SEP 1200 | 34 | 0.12 | 0.10 | 0.02 | 377. | 322. | 27 SEP 0900 | 79 | 0.00 | 0.00 | 0.00 | 55. | 89. |
| 25 SEP 1300 | 35 | 0.00 | 0.00 | 0.00 | 309. | 254. | 27 SEP 1000 | 80 | 0.00 | 0.00 | 0.00 | 53. | 85. |
| 25 SEP 1400 | 36 | 0.00 | 0.00 | 0.00 | 242. | 194. | 27 SEP 1100 | 81 | 0.00 | 0.00 | 0.00 | 51. | 81. |
| 25 SEP 1500 | 37 | 0.12 | 0.10 | 0.02 | 203. | 160. | 27 SEP 1200 | 82 | 0.00 | 0.00 | 0.00 | 50. | 79. |
| 25 SEP 1600 | 38 | 0.00 | 0.00 | 0.00 | 172. | 141. | 27 SEP 1300 | 83 | 0.00 | 0.00 | 0.00 | 48. | 77. |
| 25 SEP 1700 | 39 | 0.12 | 0.10 | 0.02 | 143. | 200. | 27 SEP 1400 | 84 | 0.00 | 0.00 | 0.00 | 47. | 73. |
| 25 SEP 1800 | 40 | 0.24 | 0.10 | 0.14 | 226. | 310. | 27 SEP 1500 | 85 | 0.00 | 0.00 | 0.00 | 45. | 71. |
| 25 SEP 1900 | 41 | 0.12 | 0.10 | 0.02 | 287. | 371. | 27 SEP 1600 | 86 | 0.00 | 0.00 | 0.00 | 44. | 69. |
| 25 SEP 2000 | 42 | 0.12 | 0.10 | 0.02 | 252. | 334. | 27 SEP 1700 | 87 | 0.00 | 0.00 | 0.00 | 42. | 67. |
| 25 SEP 2100 | 43 | 0.00 | 0.00 | 0.00 | 211. | 276. | 27 SEP 1800 | 88 | 0.00 | 0.00 | 0.00 | 41. | 65. |
| 25 SEP 2200 | 44 | 0.00 | 0.00 | 0.00 | 165. | 223. | 27 SEP 1900 | 89 | 0.00 | 0.00 | 0.00 | 40. | 63. |
| 25 SEP 2300 | 45 | 0.00 | 0.00 | 0.00 | 129. | 204. | 27 SEP 2000 | 90 | 0.00 | 0.00 | 0.00 | 39. | 62. |

TOTAL RAINFALL = 6.96, TOTAL LOSS = 3.60, TOTAL EXCESS = 3.36

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 89.00-HR |
|---|---|---|---|---|---|---|
| 1886. | 50.00 | (CFS) | 1556. | 719. | 319. | 263. |
| | | (INCHES) | 1.419 | 2.621 | 3.494 | 3.553 |
| | | (AC-FT) | 772. | 1426. | 1901. | 1933. |

CUMULATIVE AREA = 10.20 SQ MI


STATION
(O) OUTFLOW, (*) OBSERVED FLOW
0.
400.
800.
1200.
1600.
2000.
(L) PRECIP. (X) EXCESS
(-) LIMITS OF OPTIMIZATION

```
                                   HEC-1 INPUT                                              PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        ELK RUN CREEK    10-09-76
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3           IT      60 08OCT76    0600      50
  4           IO       1       2
  5           OU      24      38
  6           PG    TROY    1.59
  7           PG  JACSUM
  8           PI     .00     .00     .00     .10     .00     .00     .00     .00     .00     .00
  9           PI     .00     .00     .00     .00     .00     .10     .00     .00     .10     .00
 10           PI     .10     .10     .10     .10     .10     .10     .30     .30     .30     .10
 11           PI     .10     .00     .20     .10     .00     .00     .10     .00     .00     .00

 12           KK  ELKRUN
 13           QO       3       4       4       4       3       3       3       3       3       3
 14           QO       3       3       3       3       3       3       3       3       3       4
 15           QO       4       4       5       7       9      21      28      40      85     216
 16           QO     367     473     419     319     216     171     136     114      98      85
 17           QO      75      67      60      55      51      47      44      42      40      38
 18           PT    TROY
 19           PW      1.
 20           PR  JACSUM
 21           PW     1.0
 22           BA    10.2      0.
 23           BF      3.     47.  1.0327
 24           UC     -3.     -5.
 25           LU     -.9     -.1
 26           ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 24 THROUGH 38)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.420 | | 29.74 | | | |
| COMPUTED HYDROGRAPH | 2638. | 0.401 | 176. | 32.95 | 3.22 | 467. | 31.00 |
| OBSERVED HYDROGRAPH | 2620. | 0.398 | 175. | 32.82 | 3.09 | 473. | 31.00 |
| DIFFERENCE | 18. | 0.003 | 1. | 0.13 | 0.13 | -6. | 0.00 |
| PERCENT DIFFERENCE | 0.69 | | | | 4.17 | -1.35 | |

STANDARD ERROR 15. AVERAGE ABSOLUTE ERROR 13.
OBJECTIVE FUNCTION 15. AVERAGE PERCENT ABSOLUTE ERROR 30.33

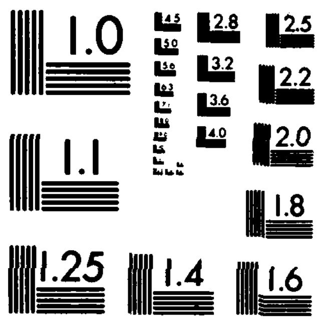
### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 50)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.420 | | 29.74 | | | |
| COMPUTED HYDROGPAPH | 3192. | 0.485 | 64. | 34.34 | 4.60 | 467. | 31.00 |
| OBSERVED HYDROGRAPH | 3399. | 0.516 | 68. | 34.56 | 4.82 | 473. | 31.00 |
| DIFFEPENCE | -207. | -0.031 | -4. | -0.22 | -0.22 | -6. | 0.00 |
| PERCENT DIFFERENCE | -6.09 | | | | -4.50 | -1.35 | |

STANDARD ERROR 13. AVERAGE ABSOLUTE ERROR 8.
OBJECTIVE FUNCTION 16. AVERAGE PERCENT ABSOLUTE ERROR 28.06

AD-A129 964 WATERSHED MODELLING IN THE CHEMUNG AND UPPER SUSQUEHANNA RIVER BASINS USI..(U) ARMY MILITARY PERSONNEL CENTER ALEXANDRIA VA J C STYRON 20 MAY 83 3/4

UNCLASSIFIED F/G 8/8 NL




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

UNIT HYDROGRAPH
12 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 203. | 676. | 1173. | 1422. | 1269. | 842. | 458. | 249. | 135. | 73. |
| 40. | 22. | | | | | | | | |

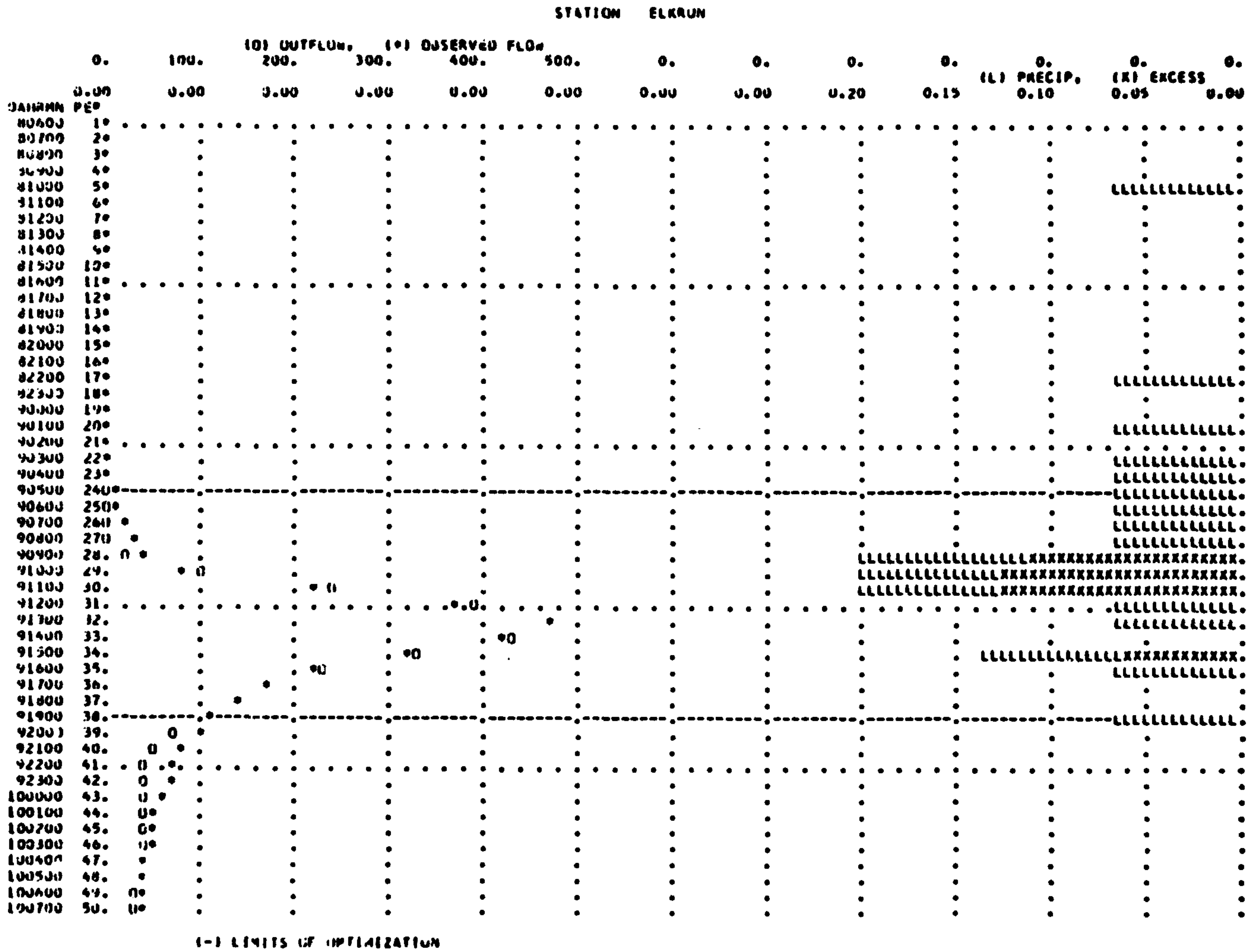
HYDROGRAPH AT STATION CLKRUN

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 OCT 0600 | 1 | 0.00 | 0.00 | 0.00 | 1. | 1. | 9 OCT 0700 | 26 | 0.07 | 0.07 | 0.00 | 1. | 21. |
| 8 OCT 0700 | 2 | 0.00 | 0.00 | 0.00 | 3. | 4. | 9 OCT 0800 | 27 | 0.07 | 0.07 | 0.00 | 1. | 28. |
| 8 OCT 0800 | 3 | 0.00 | 0.00 | 0.00 | 3. | 4. | 9 OCT 0900 | 28 | 0.20 | 0.09 | 0.11 | 23. | 40. |
| 8 OCT 0900 | 4 | 0.00 | 0.00 | 0.00 | 3. | 4. | 9 OCT 1000 | 29 | 0.20 | 0.07 | 0.13 | 101. | 85. |
| 8 OCT 1000 | 5 | 0.07 | 0.07 | 0.00 | 3. | 3. | 9 OCT 1100 | 30 | 0.20 | 0.07 | 0.13 | 240. | 216. |
| 8 OCT 1100 | 6 | 0.00 | 0.00 | 0.00 | 3. | 3. | 9 OCT 1200 | 31 | 0.07 | 0.07 | 0.03 | 390. | 367. |
| 8 OCT 1200 | 7 | 0.00 | 0.00 | 0.00 | 2. | 3. | 9 OCT 1300 | 32 | 0.07 | 0.07 | 0.00 | 467. | 473. |
| 8 OCT 1300 | 8 | 0.00 | 0.00 | 0.00 | 2. | 3. | 9 OCT 1400 | 33 | 0.00 | 0.00 | 0.00 | 431. | 419. |
| 8 OCT 1400 | 9 | 0.00 | 0.00 | 0.00 | 2. | 3. | 9 OCT 1500 | 34 | 0.13 | 0.07 | 0.06 | 328. | 319. |
| 8 OCT 1500 | 10 | 0.00 | 0.00 | 0.00 | 2. | 3. | 9 OCT 1600 | 35 | 0.07 | 0.07 | 0.00 | 231. | 216. |
| 8 OCT 1600 | 11 | 0.00 | 0.00 | 0.00 | 2. | 3. | 9 OCT 1700 | 36 | 0.00 | 0.00 | 0.00 | 174. | 171. |
| 8 OCT 1700 | 12 | 0.00 | 0.00 | 0.00 | 2. | 3. | 9 OCT 1800 | 37 | 0.00 | 0.00 | 0.00 | 141. | 136. |
| 8 OCT 1800 | 13 | 0.00 | 0.00 | 0.00 | 2. | 3. | 9 OCT 1900 | 38 | 0.07 | 0.07 | 0.00 | 106. | 114. |
| 8 OCT 1900 | 14 | 0.00 | 0.00 | 0.00 | 2. | 3. | 9 OCT 2000 | 39 | 0.00 | 0.00 | 0.00 | 67. | 96. |
| 8 OCT 2000 | 15 | 0.00 | 0.00 | 0.00 | 2. | 3. | 9 OCT 2100 | 40 | 0.00 | 0.00 | 0.00 | 46. | 85. |
| 8 OCT 2100 | 16 | 0.00 | 0.00 | 0.00 | 2. | 3. | 9 OCT 2200 | 41 | 0.00 | 0.00 | 0.00 | 45. | 75. |
| 8 OCT 2200 | 17 | 0.07 | 0.07 | 0.00 | 2. | 3. | 9 OCT 2300 | 42 | 0.00 | 0.00 | 0.00 | 44. | 67. |
| 8 OCT 2300 | 18 | 0.00 | 0.00 | 0.00 | 2. | 3. | 10 OCT 0000 | 43 | 0.00 | 0.00 | 0.00 | 42. | 60. |
| 9 OCT 0000 | 19 | 0.00 | 0.00 | 0.00 | 2. | 3. | 10 OCT 0100 | 44 | 0.00 | 0.00 | 0.00 | 41. | 55. |
| 9 OCT 0100 | 20 | 0.07 | 0.07 | 0.00 | 2. | 4. | 10 OCT 0200 | 45 | 0.00 | 0.00 | 0.00 | 40. | 51. |
| 9 OCT 0200 | 21 | 0.00 | 0.00 | 0.00 | 2. | 4. | 10 OCT 0300 | 46 | 0.00 | 0.00 | 0.00 | 38. | 47. |
| 9 OCT 0300 | 22 | 0.07 | 0.07 | 0.00 | 2. | 4. | 10 OCT 0400 | 47 | 0.00 | 0.00 | 0.00 | 37. | 44. |
| 9 OCT 0400 | 23 | 0.07 | 0.07 | 0.00 | 1. | 5. | 10 OCT 0500 | 48 | 0.00 | 0.00 | 0.00 | 36. | 42. |
| 9 OCT 0500 | 24 | 0.07 | 0.07 | 0.00 | 1. | 7. | 10 OCT 0600 | 49 | 0.00 | 0.00 | 0.00 | 35. | 40. |
| 9 OCT 0600 | 25 | 0.07 | 0.07 | 0.00 | 1. | 8. | 10 OCT 0700 | 50 | 0.00 | 0.00 | 0.00 | 34. | 38. |

TOTAL RAINFALL = 1.59, TOTAL LOSS = 1.17, TOTAL EXCESS = 0.42

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 49.00-HR |
|---|---|---|---|---|---|---|
| 467. | 31.00 | (CFS) | 342. | 130. | 65. | 65. |
| | | (INCHES) | 0.312 | 0.474 | 0.482 | 0.482 |
| | | (AC-FT) | 170. | 258. | 262. | 262. |

CUMULATIVE AREA = 10.20 SQ MI


STATION ELKRUN
(O) OUTFLOW, (*) OBSERVED FLOW
0. 100. 200. 300. 400. 500. 0. 0. 0. 0. 0. 0. 0.
(L) PRECIP, (X) EXCESS
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.20 0.15 0.10 0.05 0.00
DAHRMN PER
(-) LIMITS OF OPTIMIZATION

HEC-1 INPUT

```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID        ELK RUN CREEK   10-20-76
  2         ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
  3         IT      60 20OCT76    1300      30
  4         IU       1       2
  5         UI       7      20
  6         PG    TROY    1.44
  7         PG  JACSUM
  8         PI     .10     .10     .10     .10     .10     .20     .10     .30     .10     .20
  9         PI     .10     .00     .20     .00     .00     .00     .00     .00     .00     .00

 10         KK  ELKRUN
 11         QO       3       4       4       4       5       6      13      29      45      75
 12         QO     136     177     194     210     204     185     149     119      98      79
 13         QO      67      58      53      50      47      44      42      40      38      37
 14         PT    TROY
 15         PW      1.
 16         PR  JACSUM
 17         PW     1.0
 18         BA    10.2      0.
 19         BF      3.     45.  1.0327
 20         UC     -1.     -1.
 21         LU     -1.     -1.
 22         ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 7 THROUGH 20)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.289 | | 11.49 | | | |
| COMPUTED HYDROGRAPH | 1711. | 0.260 | 122. | 14.52 | 3.03 | 222. | 14.00 |
| OBSERVED HYDROGRAPH | 1713. | 0.260 | 122. | 14.42 | 2.92 | 210. | 13.00 |
| DIFFERENCE | -2. | -0.000 | -0. | 0.10 | 0.10 | 12. | 1.00 |
| PERCENT DIFFERENCE | -0.09 | | | | 3.58 | 5.68 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 14. | AVERAGE ABSOLUTE ERROR | 12. |
| OBJECTIVE FUNCTION | 14. | AVERAGE PERCENT ABSOLUTE ERROR | 20.32 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 30)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.289 | | 11.49 | | | |
| COMPUTED HYDROGRAPH | 2135. | 0.324 | 71. | 16.46 | 4.97 | 222. | 14.00 |
| OBSERVED HYDROGRAPH | 2215. | 0.337 | 74. | 16.56 | 5.07 | 210. | 13.00 |
| DIFFERENCE | -80. | -0.012 | -3. | -0.10 | -0.10 | 12. | 1.00 |
| PERCENT DIFFERENCE | -3.59 | | | | -1.93 | 5.68 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 11. | AVERAGE ABSOLUTE ERROR | 8. |
| OBJECTIVE FUNCTION | 13. | AVERAGE PERCENT ABSOLUTE ERROR | 17.45 |

UNIT HYDROGRAPH
21 END-OF-PERIOD ORDINATES

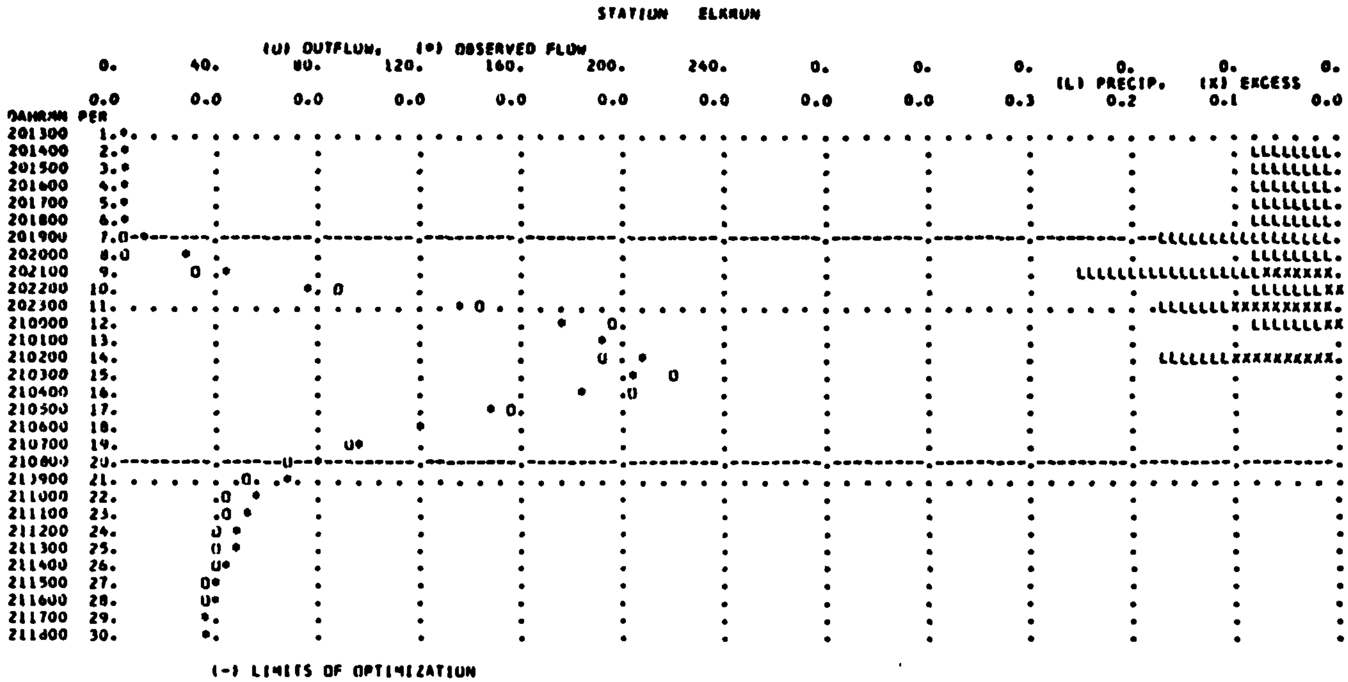
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 418. | 1103. | 1207. | 919. | 700. | 533. | 406. | 309. | 235. | 179. |
| 137. | 104. | 79. | 60. | 46. | 35. | 27. | 20. | 15. | 12. |
| 7. | | | | | | | | | |

HYDROGRAPH AT STATION ELKRUN

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 OCT 1300 | 1 | 0.00 | 0.00 | 0.00 | 3. | 3. | 21 OCT 0400 | 16 | 0.00 | 0.00 | 0.00 | 205. | 185. |
| 20 OCT 1400 | 2 | 0.08 | 0.08 | 0.00 | 3. | 4. | 21 OCT 0500 | 17 | 0.00 | 0.00 | 0.00 | 156. | 149. |
| 20 OCT 1500 | 3 | 0.08 | 0.08 | 0.00 | 3. | 4. | 21 OCT 0600 | 18 | 0.00 | 0.00 | 0.00 | 119. | 119. |
| 20 OCT 1600 | 4 | 0.08 | 0.08 | 0.00 | 3. | 4. | 21 OCT 0700 | 19 | 0.00 | 0.00 | 0.00 | 91. | 98. |
| 20 OCT 1700 | 5 | 0.08 | 0.08 | 0.00 | 3. | 5. | 21 OCT 0800 | 20 | 0.00 | 0.00 | 0.00 | 70. | 79. |
| 20 OCT 1800 | 6 | 0.08 | 0.08 | 0.00 | 3. | 6. | 21 OCT 0900 | 21 | 0.00 | 0.00 | 0.00 | 54. | 67. |
| 20 OCT 1900 | 7 | 0.17 | 0.17 | 0.00 | 2. | 13. | 21 OCT 1000 | 22 | 0.00 | 0.00 | 0.00 | 45. | 58. |
| 20 OCT 2000 | 8 | 0.08 | 0.08 | 0.00 | 2. | 29. | 21 OCT 1100 | 23 | 0.00 | 0.00 | 0.00 | 43. | 53. |
| 20 OCT 2100 | 9 | 0.25 | 0.18 | 0.07 | 33. | 45. | 21 OCT 1200 | 24 | 0.00 | 0.00 | 0.00 | 42. | 50. |
| 20 OCT 2200 | 10 | 0.08 | 0.07 | 0.01 | 88. | 75. | 21 OCT 1300 | 25 | 0.00 | 0.00 | 0.00 | 40. | 47. |
| 20 OCT 2300 | 11 | 0.17 | 0.07 | 0.10 | 144. | 136. | 21 OCT 1400 | 26 | 0.00 | 0.00 | 0.00 | 39. | 44. |
| 21 OCT 0000 | 12 | 0.08 | 0.07 | 0.01 | 194. | 177. | 21 OCT 1500 | 27 | 0.00 | 0.00 | 0.00 | 38. | 42. |
| 21 OCT 0100 | 13 | 0.00 | 0.00 | 0.00 | 193. | 194. | 21 OCT 1600 | 28 | 0.00 | 0.00 | 0.00 | 37. | 40. |
| 21 OCT 0200 | 14 | 0.17 | 0.07 | 0.10 | 192. | 210. | 21 OCT 1700 | 29 | 0.00 | 0.00 | 0.00 | 36. | 38. |
| 21 OCT 0300 | 15 | 0.00 | 0.00 | 0.00 | 222. | 204. | 21 OCT 1800 | 30 | 0.00 | 0.00 | 0.00 | 34. | 37. |

TOTAL RAINFALL = 1.44, TOTAL LOSS = 1.15, TOTAL EXCESS = 0.29

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 29.00-HR |
|---|---|---|---|---|---|---|
| 222. | 14.00 | (CFS) | 193. | 88. | 73. | 73. |
| | | (INCHES) | 0.176 | 0.319 | 0.322 | 0.322 |
| | | (AC-FT) | 95. | 174. | 175. | 175. |


STATION ELKRUN
(U) OUTFLOW, (*) OBSERVED FLOW
0. 40. 80. 120. 160. 200. 240. 0. 0. 0. 0. 0. 0.
(L) PRECIP. (X) EXCESS
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.3 0.2 0.1 0.0
DAHRMN PER
201300 1.
201400 2.
201500 3.
201600 4.
201700 5.
201800 6.
201900 7.
202000 8.
202100 9.
202200 10.
202300 11.
210000 12.
210100 13.
210200 14.
210300 15.
210400 16.
210500 17.
210600 18.
210700 19.
210800 20.
210900 21.
211000 22.
211100 23.
211200 24.
211300 25.
211400 26.
211500 27.
211600 28.
211700 29.
211800 30.
(-) LIMITS OF OPTIMIZATION

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                                              HEC-1 INPUT                                              PAGE  1

 LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1           ID        ELK RUN CREEK   5-14-78
   2           ID        UNIT GRAPH (CLARK) AND LOSS RATE (UNIFORM) OPTIMIZATION
   3           IT      60 14MAY78    0300      40
   4           IO       1       2
   5           OU       5      15
   6           PG    TROY    1.22
   7           PG  JACSUM
   8           PI     .00     .00     .10     .10     .00     .10     .20     .10     .00     .00
   9           PI     .50     .20     .00     .00     .00     .00     .00     .00     .00     .00
  10           PI     .00     .00     .00     .00     .00     .00     .00     .00     .10     .00

  11           KK  ELKRUN
  12           QO      15      15      18      24      42      91     154     213     257     398
  13           QO     735    1061     798     545     412     304     254     223     201     187
  14           QO     176     165     157     146     137     132     132     139     154     149
  15           QO     141     129     124     115     108     102      95      91      87      83
  16           PT    TROY
  17           PW      1.
  18           PR  JACSUM
  19           PW     1.0
  20           BA    10.2      0.
  21           SF     15.     85.  1.0327
  22           UC     -1.     -1.
  23           LU     -1.     -1.
  24           ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 5 THROUGH 15)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.911 | | 11.68 | | | |
| COMPUTED HYDROGRAPH | 4738. | 0.720 | 431. | 11.75 | 0.06 | 1026. | 12.00 |
| OBSERVED HYDROGRAPH | 4706. | 0.715 | 428. | 11.65 | -0.03 | 1061. | 11.00 |
| DIFFERENCE | 32. | 0.005 | 3. | 0.10 | 0.10 | -35. | 1.00 |
| PERCENT DIFFERENCE | 0.68 | | | | ****** | -3.29 | |

STANDARD ERROR 245. AVERAGE ABSOLUTE ERROR 184.
OBJECTIVE FUNCTION 290. AVERAGE PERCENT ABSOLUTE ERROR 44.74

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 40)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.911 | | 11.68 | | | |
| COMPUTED HYDROGRAPH | 7241. | 1.100 | 181. | 16.24 | 4.55 | 1026. | 12.00 |
| OBSERVED HYDROGRAPH | 8509. | 1.293 | 213. | 17.76 | 6.07 | 1061. | 11.00 |
| DIFFERENCE | -1268. | -0.193 | -32. | -1.52 | -1.52 | -35. | 1.00 |
| PERCENT DIFFERENCE | -14.90 | | | | -25.05 | -3.29 | |

STANDARD ERROR 138. AVERAGE ABSOLUTE ERROR 86.
OBJECTIVE FUNCTION 220. AVERAGE PERCENT ABSOLUTE ERROR 40.01

UNIT HYDROGRAPH
13 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1124. | 1084. | 1247. | 812. | 528. | 344. | 224. | 145. | 95. | 62. |
| 40. | 26. | 17. | | | | | | | |

HYDROGRAPH AT STATION ELKRUN

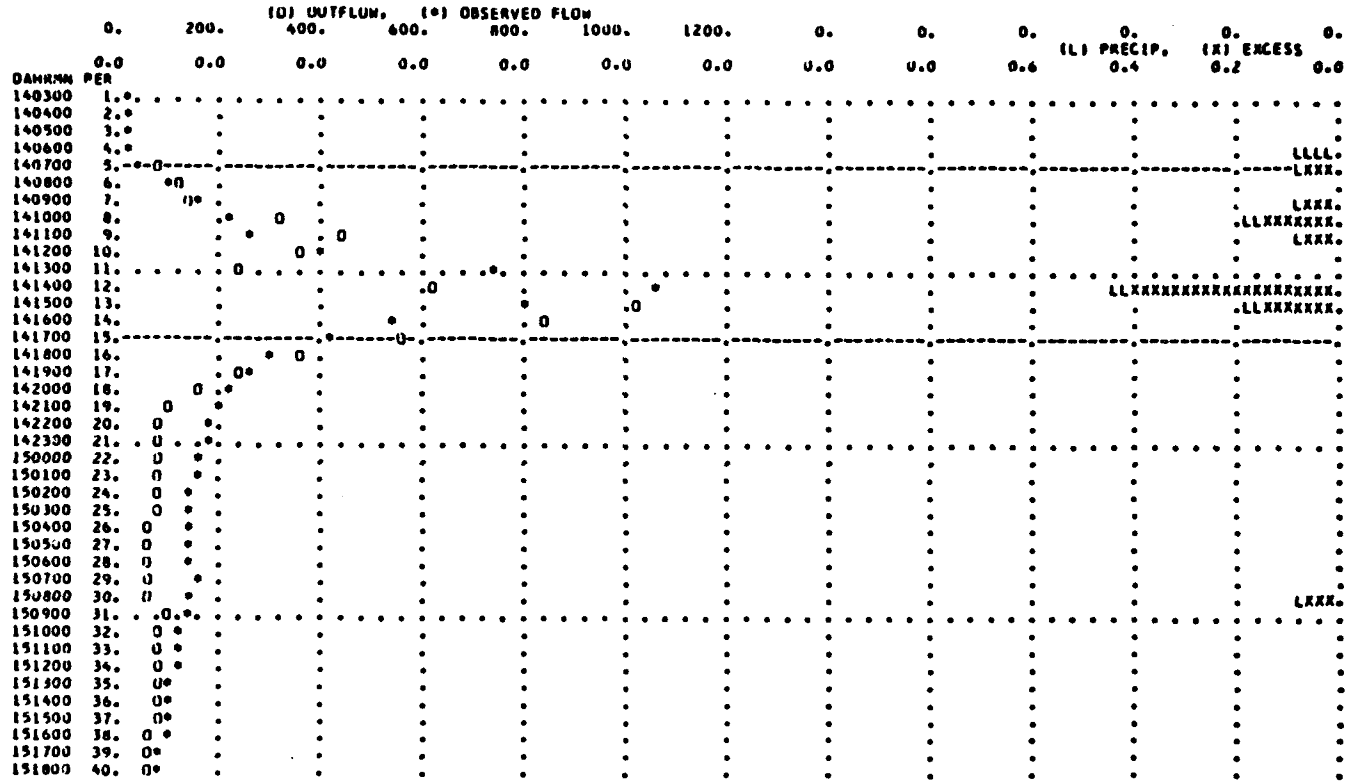
| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 14 MAY 0300 | 1 | 0.00 | 0.00 | 0.00 | 15. | 15. |
| 14 MAY 0400 | 2 | 0.00 | 0.00 | 0.00 | 15. | 15. |
| 14 MAY 0500 | 3 | 0.00 | 0.00 | 0.00 | 14. | 18. |
| 14 MAY 0600 | 4 | 0.09 | 0.09 | 0.00 | 17. | 24. |
| 14 MAY 0700 | 5 | 0.09 | 0.03 | 0.05 | 81. | 42. |
| 14 MAY 0800 | 6 | 0.00 | 0.00 | 0.00 | 120. | 91. |
| 14 MAY 0900 | 7 | 0.09 | 0.03 | 0.05 | 146. | 154. |
| 14 MAY 1000 | 8 | 0.17 | 0.03 | 0.14 | 322. | 213. |
| 14 MAY 1100 | 9 | 0.09 | 0.03 | 0.05 | 440. | 257. |
| 14 MAY 1200 | 10 | 0.00 | 0.00 | 0.00 | 356. | 398. |
| 14 MAY 1300 | 11 | 0.00 | 0.00 | 0.00 | 236. | 735. |
| 14 MAY 1400 | 12 | 0.44 | 0.03 | 0.40 | 613. | 1061. |
| 14 MAY 1500 | 13 | 0.17 | 0.03 | 0.14 | 1026. | 798. |
| 14 MAY 1600 | 14 | 0.00 | 0.00 | 0.00 | 843. | 545. |
| 14 MAY 1700 | 15 | 0.00 | 0.00 | 0.00 | 555. | 412. |
| 14 MAY 1800 | 16 | 0.00 | 0.00 | 0.00 | 364. | 304. |
| 14 MAY 1900 | 17 | 0.00 | 0.00 | 0.00 | 240. | 254. |
| 14 MAY 2000 | 18 | 0.00 | 0.00 | 0.00 | 158. | 223. |
| 14 MAY 2100 | 19 | 0.00 | 0.00 | 0.00 | 106. | 201. |
| 14 MAY 2200 | 20 | 0.00 | 0.00 | 0.00 | 84. | 187. |

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 14 MAY 2300 | 21 | 0.00 | 0.00 | 0.00 | 81. | 176. |
| 15 MAY 0000 | 22 | 0.00 | 0.00 | 0.00 | 79. | 165. |
| 15 MAY 0100 | 23 | 0.00 | 0.00 | 0.00 | 76. | 157. |
| 15 MAY 0200 | 24 | 0.00 | 0.00 | 0.00 | 74. | 146. |
| 15 MAY 0300 | 25 | 0.00 | 0.00 | 0.00 | 71. | 137. |
| 15 MAY 0400 | 26 | 0.00 | 0.00 | 0.00 | 69. | 132. |
| 15 MAY 0500 | 27 | 0.00 | 0.00 | 0.00 | 67. | 132. |
| 15 MAY 0600 | 28 | 0.00 | 0.00 | 0.00 | 65. | 139. |
| 15 MAY 0700 | 29 | 0.00 | 0.00 | 0.00 | 63. | 154. |
| 15 MAY 0800 | 30 | 0.09 | 0.03 | 0.05 | 68. | 149. |
| 15 MAY 0900 | 31 | 0.00 | 0.00 | 0.00 | 109. | 141. |
| 15 MAY 1000 | 32 | 0.00 | 0.00 | 0.00 | 84. | 129. |
| 15 MAY 1100 | 33 | 0.00 | 0.00 | 0.00 | 81. | 124. |
| 15 MAY 1200 | 34 | 0.00 | 0.00 | 0.00 | 79. | 115. |
| 15 MAY 1300 | 35 | 0.00 | 0.00 | 0.00 | 76. | 108. |
| 15 MAY 1400 | 36 | 0.00 | 0.00 | 0.00 | 74. | 102. |
| 15 MAY 1500 | 37 | 0.00 | 0.00 | 0.00 | 72. | 95. |
| 15 MAY 1600 | 38 | 0.00 | 0.00 | 0.00 | 69. | 91. |
| 15 MAY 1700 | 39 | 0.00 | 0.00 | 0.00 | 67. | 87. |
| 15 MAY 1800 | 40 | 0.00 | 0.00 | 0.00 | 65. | 83. |

TOTAL RAINFALL = 1.22, TOTAL LOSS = 0.31, TOTAL EXCESS = 0.91

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 39.00-HR |
|---|---|---|---|---|---|---|
| 1026. | 12.00 | (CFS) | 606. | 261. | 185. | 185. |
| | | (INCHES) | 0.553 | 0.951 | 1.094 | 1.094 |
| | | (AC-FT) | 301. | 518. | 595. | 595. |

STATION ELKRUN




(-) LIMITS OF OPTIMIZATION

```
                                        HEC-1 INPUT                                                   PAGE  1

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID        ELK RUN CRFEK      8-06-78
  2         ID        UNIT GRAPH (CLARK) AND LUSS RATE (UNIFORM) UPTIMIZATION
  3         IT      60  5AUG78     2100      37
  4         IO       1       2
  5         OU       8      20
  6         PG    TROY    1.54
  7         PG  JACSUM
  8         PI      .1      .0      .0      .0      .0      .0      .1      .2      .0      .0
  9         PI      .2      .6      .5      .3      .0      .0      .0      .1      .0      .0

 10         KK  ELKRUN
 11         QO       3       3       3       3       3       3       3       4       5      41
 12         QO      95      87      74     139     176     236     236     151     108      79
 13         QO      70      66      59      52      45      41      36      33      32      29
 14         QO      28      27      25      24      22      21      20       0       0       0
 15         PT    TROY
 16         PW     1.0
 17         PR  JACSUM
 18         PW     1.0
 19         BA    10.2      0.
 20         BF      3.     34.  1.0327
 21         UC     -3.     -7.
 22         LU    -1.1     -1.
 23         ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 8 THROUGH 20)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.457 | | 14.22 | | | |
| COMPUTED HYDROGRAPH | 1429. | 0.217 | 110. | 16.94 | 2.72 | 256. | 15.00 |
| OBSERVED HYDROGRAPH | 1431. | 0.217 | 110. | 15.56 | 1.34 | 236. | 15.00 |
| DIFFERENCE | -2. | -0.000 | -0. | 1.38 | 1.38 | 20. | 0.00 |
| PERCENT DIFFERENCE | -0.16 | | | | 103.24 | 8.30 | |
| STANDARD ERROR | | 58. | | AVERAGE ABSOLUTE ERROR | | 48. | |
| OBJECTIVE FUNCTION | | 57. | | AVERAGE PERCENT ABSOLUTE ERROR | | 58.40 | |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 37)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0 457 | | 14.22 | | | |
| COMPUTED HYDROGRAPH | 2785. | 0.423 | 75. | 21.55 | 7.33 | 256. | 15.00 |
| OBSERVED HYDROGRAPH | 2082. | 0.316 | 56. | 18.92 | 4.70 | 236. | 15.00 |
| DIFFERENCE | 703. | 0.107 | 19. | 2.63 | 2.63 | 20. | 0.00 |
| PERCENT DIFFERENCE | 33.75 | | | | 55.86 | 8.30 | |
| STANDARD ERROR | | 47. | | AVERAGE ABSOLUTE ERROR | | 36. | |
| OBJECTIVE FUNCTION | | 57. | | AVERAGE PERCENT ABSOLUTE ERROR | | 85.60 | |

UNIT HYDROGRAPH
56 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 315. | 598. | 553. | 491. | 444. | 402. | 363. | 328. | 297. | 268. |
| 243. | 219. | 198. | 179. | 162. | 147. | 133. | 120. | 109. | 98. |
| 89. | 80. | 73. | 66. | 59. | 54. | 49. | 44. | 40. | 36. |
| 32. | 29. | 27. | 24. | 22. | 20. | 18. | 16. | 14. | 13. |
| 12. | 11. | 10. | 9. | 8. | 7. | 6. | 6. | 5. | 5. |
| 4. | 4. | 4. | 3. | | | | | | |

HYDROGRAPH AT STATION ELKRUN

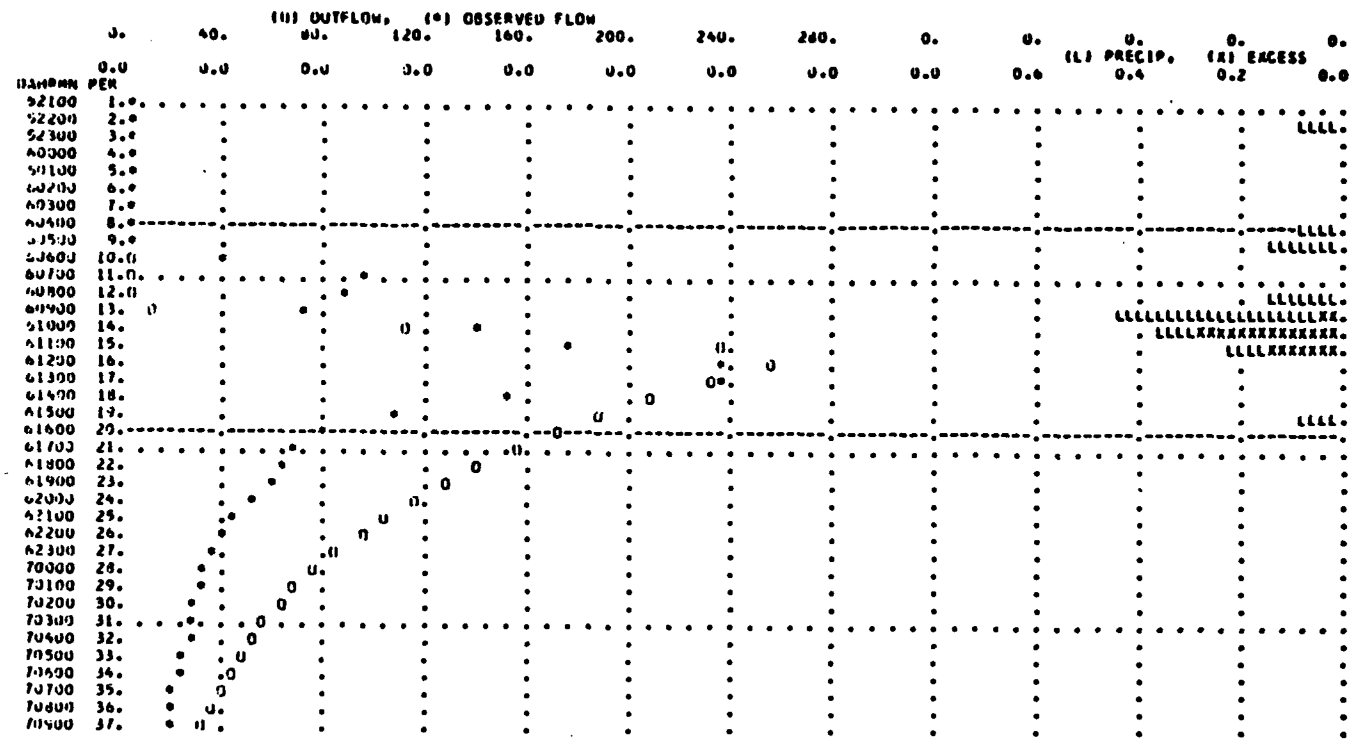
| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 AUG 2100 | 1 | 0.00 | 0.00 | 0.00 | 3. | 3. | 6 AUG 1600 | 20 | 0.00 | 0.00 | 0.00 | 171. | 79. |
| 5 AUG 2200 | 2 | 0.07 | 0.07 | 0.00 | 3. | 3. | 6 AUG 1700 | 21 | 0.00 | 0.00 | 0.00 | 155. | 70. |
| 5 AUG 2300 | 3 | 0.00 | 0.00 | 0.00 | 3. | 3. | 6 AUG 1800 | 22 | 0.00 | 0.00 | 0.00 | 140. | 66. |
| 6 AUG 0000 | 4 | 0.00 | 0.00 | 0.00 | 3. | 3. | 6 AUG 1900 | 23 | 0.00 | 0.00 | 0.00 | 127. | 59. |
| 6 AUG 0100 | 5 | 0.00 | 0.00 | 0.00 | 3. | 3. | 6 AUG 2000 | 24 | 0.00 | 0.00 | 0.00 | 115. | 52. |
| 6 AUG 0200 | 6 | 0.00 | 0.00 | 0.00 | 3. | 3. | 6 AUG 2100 | 25 | 0.00 | 0.00 | 0.00 | 104. | 45. |
| 6 AUG 0300 | 7 | 0.00 | 0.00 | 0.00 | 2. | 3. | 6 AUG 2200 | 26 | 0.00 | 0.00 | 0.00 | 94. | 41. |
| 6 AUG 0400 | 8 | 0.07 | 0.07 | 0.00 | 2. | 4. | 6 AUG 2300 | 27 | 0.00 | 0.00 | 0.00 | 85. | 36. |
| 6 AUG 0500 | 9 | 0.15 | 0.15 | 0.00 | 2. | 5. | 7 AUG 0000 | 28 | 0.00 | 0.00 | 0.00 | 77. | 33. |
| 6 AUG 0600 | 10 | 0.00 | 0.00 | 0.00 | 2. | 41. | 7 AUG 0100 | 29 | 0.00 | 0.00 | 0.00 | 70. | 32. |
| 6 AUG 0700 | 11 | 0.00 | 0.00 | 0.00 | 2. | 95. | 7 AUG 0200 | 30 | 0.00 | 0.00 | 0.00 | 63. | 29. |
| 6 AUG 0800 | 12 | 0.15 | 0.15 | 0.00 | 2. | 87. | 7 AUG 0300 | 31 | 0.00 | 0.00 | 0.00 | 57. | 28. |
| 6 AUG 0900 | 13 | 0.44 | 0.40 | 0.04 | 13. | 74. | 7 AUG 0400 | 32 | 0.00 | 0.00 | 0.00 | 52. | 27. |
| 6 AUG 1000 | 14 | 0.37 | 0.08 | 0.28 | 112. | 139. | 7 AUG 0500 | 33 | 0.00 | 0.00 | 0.00 | 47. | 25. |
| 6 AUG 1100 | 15 | 0.22 | 0.08 | 0.14 | 234. | 176. | 7 AUG 0600 | 34 | 0.00 | 0.00 | 0.00 | 43. | 24. |
| 6 AUG 1200 | 16 | 0.00 | 0.00 | 0.00 | 256. | 236. | 7 AUG 0700 | 35 | 0.00 | 0.00 | 0.00 | 39. | 22. |
| 6 AUG 1300 | 17 | 0.00 | 0.00 | 0.00 | 232. | 236. | 7 AUG 0800 | 36 | 0.00 | 0.00 | 0.00 | 35. | 21. |
| 6 AUG 1400 | 18 | 0.00 | 0.00 | 0.00 | 209. | 151. | 7 AUG 0900 | 37 | 0.00 | 0.00 | 0.00 | 33. | 20. |
| 6 AUG 1500 | 19 | 0.07 | 0.07 | 0.00 | 190. | 108. | | | | | | | |

TOTAL RAINFALL = 1.54, TOTAL LOSS = 1.08, TOTAL EXCESS = 0.46

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 36.00-HR |
|---|---|---|---|---|---|---|
| 256. | 15.00 | (CFS) | 210. | 114. | 77. | 77. |
| | | (INCHES) | 0.192 | 0.415 | 0.420 | 0.420 |
| | | (AC-FT) | 104. | 226. | 229. | 229. |

CUMULATIVE AREA = 13.20 SQ MI

STATION ELKRUN



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                                             HEC-1 INPUT                                                  PAGE  1

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID        FIVE MILE CREEK     5-07-75
  2         ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3         IT      60 06MAY75     0800      70
  4         IO       1       2
  5         OU       1      35
  6         PG    PRAT    1.18
  7         PG     H-A
  8         PI     .10     .10     .20     .30     .30     .10     .10     .10     .00     .00

  9         KK  KANUNA
 10         QO     330     318     305     299     296     312     371     511     716     860
 11         QO     950    1006    1013     992     971     964     957     978     985     992
 12         QO    1006    1006    1027    1037    1020    1020    1027     999     999     985
 13         QO     964     964     957     920     896     884     860     836     806     782
 14         QO     752     728     690     665     640     610     580     547     525     498
 15         QO     471     447     427     395     374     357     334     312     296     262
 16         QO     265     255     242     234     224     216     206     199     195     186
 17         PT    PRAT
 18         PW    1.00
 19         PK     H-A
 20         PW    1.00
 21         BA    66.8      0.
 22         BF    330.    168.  1.0318
 23         UC     -9.    -18.
 24         LU     -1.    -.05
 25         ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 1 THROUGH 35)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.864 | | 5.86 | | | |
| COMPUTED HYDROGRAPH | 28968. | 0.672 | 828. | 20.35 | 14.48 | 1268. | 18.00 |
| OBSERVED HYDROGRAPH | 28953. | 0.672 | 827. | 20.49 | 14.62 | 1037. | 23.00 |
| DIFFERENCE | 15. | 0.000 | 0. | -0.14 | -0.14 | 231. | -5.00 |
| PERCENT DIFFERENCE | 0.05 | | | | -0.96 | 22.27 | |

STANDARD ERROR 154. AVERAGE ABSOLUTE ERROR 121.
OBJECTIVE FUNCTION 159. AVERAGE PERCENT ABSOLUTE ERROR 13.25

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 70)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.864 | | 5.86 | | | |
| COMPUTED HYDROGRAPH | 42848. | 0.994 | 612. | 29.71 | 23.84 | 1268. | 18.00 |
| OBSERVED HYDROGRAPH | 45275. | 1.050 | 647. | 30.50 | 24.63 | 1037. | 23.00 |
| DIFFERENCE | -2427. | -0.056 | -35. | -0.79 | -0.79 | 231. | -5.00 |
| PERCENT DIFFERENCE | -5.36 | | | | -3.22 | 22.27 | |

STANDARD ERROR 130. AVERAGE ABSOLUTE ERROR 98.
OBJECTIVE FUNCTION 147. AVERAGE PERCENT ABSOLUTE ERROR 12.81

UNIT HYDROGRAPH
143 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 21. | 79. | 163. | 264. | 378. | 503. | 636. | 774. | 905. | 1019. |
| 1115. | 1193. | 1249. | 1282. | 1279. | 1243. | 1195. | 1149. | 1103. | 1062. |
| 1021. | 982. | 944. | 908. | 873. | 839. | 807. | 776. | 746. | 717. |
| 689. | 663. | 637. | 613. | 589. | 566. | 544. | 523. | 503. | 484. |
| 465. | 447. | 430. | 413. | 398. | 382. | 367. | 353. | 340. | 327. |
| 314. | 302. | 290. | 279. | 268. | 258. | 248. | 238. | 229. | 220. |
| 212. | 204. | 196. | 188. | 181. | 174. | 167. | 161. | 155. | 149. |
| 143. | 138. | 132. | 127. | 122. | 118. | 113. | 109. | 104. | 100. |
| 97. | 93. | 89. | 86. | 83. | 79. | 76. | 73. | 71. | 68. |
| 65. | 63. | 60. | 58. | 56. | 54. | 51. | 50. | 48. | 46. |
| 44. | 42. | 41. | 39. | 38. | 36. | 35. | 33. | 32. | 31. |
| 30. | 29. | 27. | 26. | 25. | 24. | 23. | 22. | 22. | 21. |
| 20. | 19. | 19. | 18. | 17. | 16. | 16. | 15. | 15. | 14. |
| 14. | 13. | 13. | 12. | 12. | 11. | 11. | 10. | 10. | 9. |
| 9. | 9. | 8. | | | | | | | |

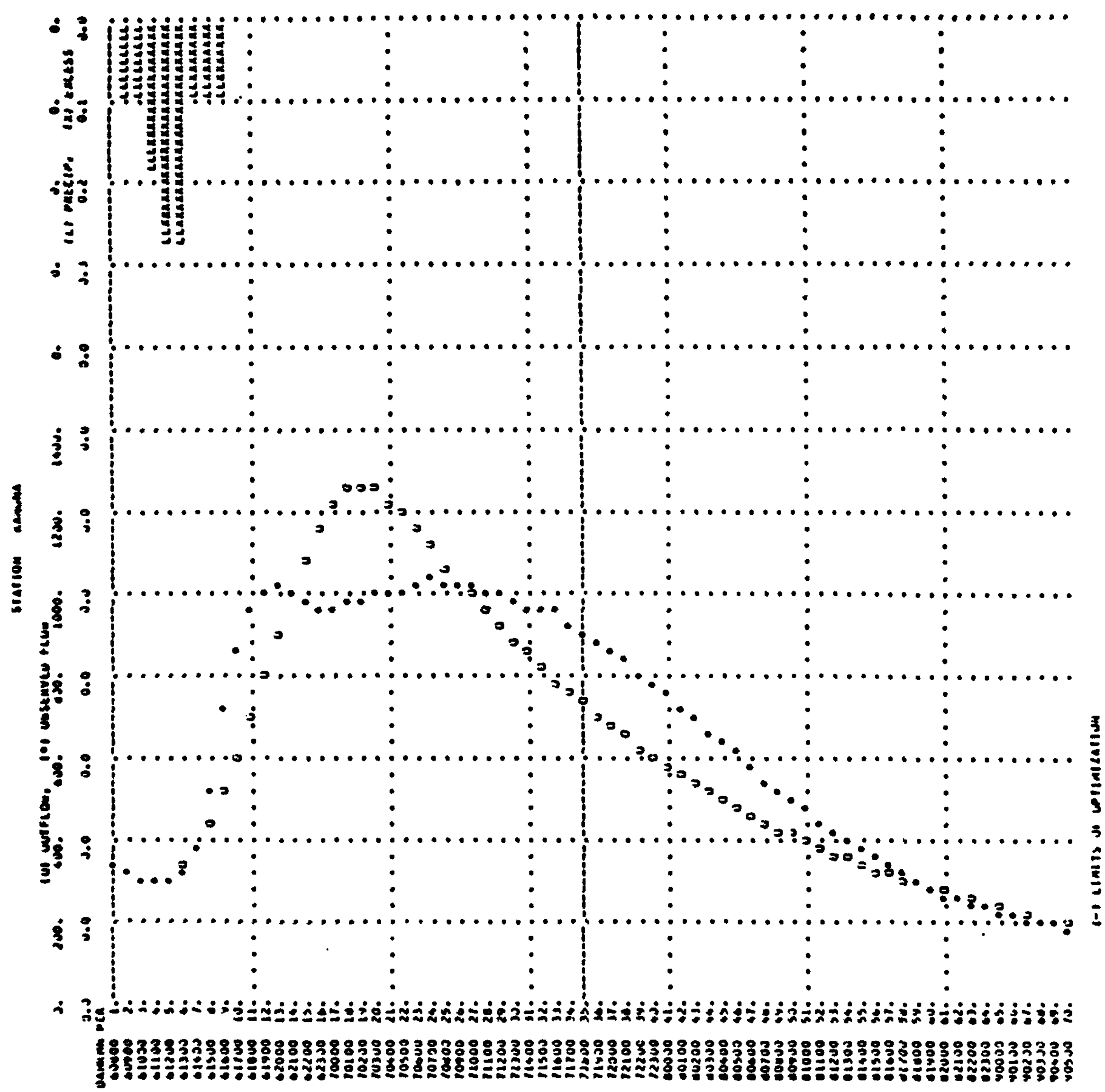
HYDROGRAPH AT STATION KANONA

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 6 MAY 0800 | 1 | 0.00 | 0.00 | 0.00 | 330. | 330. |
| 6 MAY 0900 | 2 | 0.09 | 0.09 | 0.00 | 320. | 316. |
| 6 MAY 1000 | 3 | 0.09 | 0.09 | 0.00 | 313. | 305. |
| 6 MAY 1100 | 4 | 0.18 | 0.04 | 0.15 | 303. | 299. |
| 6 MAY 1200 | 5 | 0.27 | 0.02 | 0.25 | 308. | 294. |
| 6 MAY 1300 | 6 | 0.27 | 0.02 | 0.25 | 331. | 312. |
| 6 MAY 1400 | 7 | 0.09 | 0.02 | 0.07 | 374. | 371. |
| 6 MAY 1500 | 8 | 0.09 | 0.02 | 0.07 | 435. | 511. |
| 6 MAY 1600 | 9 | 0.09 | 0.02 | 0.07 | 511. | 716. |
| 6 MAY 1700 | 10 | 0.00 | 0.00 | 0.00 | 630. | 860. |
| 6 MAY 1800 | 11 | 0.00 | 0.00 | 0.00 | 749. | 950. |
| 6 MAY 1900 | 12 | 0.00 | 0.00 | 0.00 | 833. | 1006. |
| 6 MAY 2000 | 13 | 0.00 | 0.00 | 0.00 | 907. | 1013. |
| 6 MAY 2100 | 14 | 0.00 | 0.00 | 0.00 | 1004. | 992. |
| 6 MAY 2200 | 15 | 0.00 | 0.00 | 0.00 | 1040. | 971. |
| 6 MAY 2300 | 16 | 0.00 | 0.00 | 0.00 | 1162. | 964. |
| 7 MAY 0000 | 17 | 0.00 | 0.00 | 0.00 | 1219. | 957. |
| 7 MAY 0100 | 18 | 0.00 | 0.00 | 0.00 | 1255. | 978. |
| 7 MAY 0200 | 19 | 0.00 | 0.00 | 0.00 | 1264. | 985. |
| 7 MAY 0300 | 20 | 0.00 | 0.00 | 0.00 | 1257. | 992. |
| 7 MAY 0400 | 21 | 0.00 | 0.00 | 0.00 | 1233. | 1006. |
| 7 MAY 0500 | 22 | 0.00 | 0.00 | 0.00 | 1194. | 1038. |
| 7 MAY 0600 | 23 | 0.00 | 0.00 | 0.00 | 1153. | 1027. |
| 7 MAY 0700 | 24 | 0.00 | 0.00 | 0.00 | 1111. | 1037. |
| 7 MAY 0800 | 25 | 0.00 | 0.00 | 0.00 | 1069. | 1020. |
| 7 MAY 0900 | 26 | 0.00 | 0.00 | 0.00 | 1029. | 1020. |
| 7 MAY 1000 | 27 | 0.00 | 0.00 | 0.00 | 991. | 1027. |
| 7 MAY 1100 | 28 | 0.00 | 0.00 | 0.00 | 954. | 999. |
| 7 MAY 1200 | 29 | 0.00 | 0.00 | 0.00 | 918. | 999. |
| 7 MAY 1300 | 30 | 0.00 | 0.00 | 0.00 | 884. | 985. |
| 7 MAY 1400 | 31 | 0.00 | 0.00 | 0.00 | 851. | 964. |
| 7 MAY 1500 | 32 | 0.00 | 0.00 | 0.00 | 819. | 964. |
| 7 MAY 1600 | 33 | 0.00 | 0.00 | 0.00 | 788. | 957. |
| 7 MAY 1700 | 34 | 0.00 | 0.00 | 0.00 | 759. | 920. |
| 7 MAY 1800 | 35 | 0.00 | 0.00 | 0.00 | 731. | 898. |
| 7 MAY 1900 | 36 | 0.00 | 0.00 | 0.00 | 705. | 884. |
| 7 MAY 2000 | 37 | 0.00 | 0.00 | 0.00 | 677. | 860. |
| 7 MAY 2100 | 38 | 0.00 | 0.00 | 0.00 | 652. | 836. |
| 7 MAY 2200 | 39 | 0.00 | 0.00 | 0.00 | 627. | 830. |
| 7 MAY 2300 | 40 | 0.00 | 0.00 | 0.00 | 604. | 782. |
| 8 MAY 0000 | 41 | 0.00 | 0.00 | 0.00 | 582. | 752. |
| 8 MAY 0100 | 42 | 0.00 | 0.00 | 0.00 | 560. | 720. |
| 8 MAY 0200 | 43 | 0.00 | 0.00 | 0.00 | 539. | 690. |
| 8 MAY 0300 | 44 | 0.00 | 0.00 | 0.00 | 519. | 665. |
| 8 MAY 0400 | 45 | 0.00 | 0.00 | 0.00 | 500. | 640. |
| 8 MAY 0500 | 46 | 0.00 | 0.00 | 0.00 | 481. | 610. |
| 8 MAY 0600 | 47 | 0.00 | 0.00 | 0.00 | 463. | 580. |
| 8 MAY 0700 | 48 | 0.00 | 0.00 | 0.00 | 446. | 547. |
| 8 MAY 0800 | 49 | 0.00 | 0.00 | 0.00 | 429. | 525. |
| 8 MAY 0900 | 50 | 0.00 | 0.00 | 0.00 | 413. | 498. |
| 8 MAY 1000 | 51 | 0.00 | 0.00 | 0.00 | 398. | 471. |
| 8 MAY 1100 | 52 | 0.00 | 0.00 | 0.00 | 383. | 447. |
| 8 MAY 1200 | 53 | 0.00 | 0.00 | 0.00 | 369. | 427. |
| 8 MAY 1300 | 54 | 0.00 | 0.00 | 0.00 | 355. | 395. |
| 8 MAY 1400 | 55 | 0.00 | 0.00 | 0.00 | 342. | 374. |
| 8 MAY 1500 | 56 | 0.00 | 0.00 | 0.00 | 329. | 357. |
| 8 MAY 1600 | 57 | 0.00 | 0.00 | 0.00 | 317. | 334. |
| 8 MAY 1700 | 58 | 0.00 | 0.00 | 0.00 | 305. | 312. |
| 8 MAY 1800 | 59 | 0.00 | 0.00 | 0.00 | 294. | 296. |
| 8 MAY 1900 | 60 | 0.00 | 0.00 | 0.00 | 283. | 282. |
| 8 MAY 2000 | 61 | 0.00 | 0.00 | 0.00 | 272. | 265. |
| 8 MAY 2100 | 62 | 0.00 | 0.00 | 0.00 | 262. | 255. |
| 8 MAY 2200 | 63 | 0.00 | 0.00 | 0.00 | 253. | 242. |
| 8 MAY 2300 | 64 | 0.00 | 0.00 | 0.00 | 243. | 234. |
| 9 MAY 0000 | 65 | 0.00 | 0.00 | 0.00 | 234. | 224. |
| 9 MAY 0100 | 66 | 0.00 | 0.00 | 0.00 | 225. | 216. |
| 9 MAY 0200 | 67 | 0.00 | 0.00 | 0.00 | 217. | 206. |
| 9 MAY 0300 | 68 | 0.00 | 0.00 | 0.00 | 209. | 199. |
| 9 MAY 0400 | 69 | 0.00 | 0.00 | 0.00 | 201. | 195. |
| 9 MAY 0500 | 70 | 0.00 | 0.00 | 0.00 | 194. | 188. |

TOTAL RAINFALL = 1.18, TOTAL LOSS = 0.32, TOTAL EXCESS = 0.86

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 69.00-HR |
|---|---|---|---|---|---|---|
| 1264. | 19.00 | (CFS) | 1234. | 1016. | 617. | 617. |
| | | (INCHES) | 0.172 | 0.567 | 0.988 | 0.988 |
| | | (AC-FT) | 612. | 2019. | 3520. | 3520. |

CUMULATIVE AREA = 66.83 SQ MI


STATION
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS
(-) LIMITS OF OPTIMIZATION

HEC-1 INPUT PAGE 1

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LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.......10

  1            ID        FIVE MILE CREEK     9-26-75
  2            ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3            IT      60 24SEP75    2400      110
  4            IO       1       2
  5            OU       5      50
  6            PG    PRAT    4.59
  7            PG      TH
  8            PI     .05     .04     .05     .05     .06     .17     .18     .15     .15     .05
  9            PI     .25     .16     .03     .01     .05     .10     .12     .06     .07     .20
 10            PI     .20     .15     .10     .31     .22     .17     .10     .11     .06     .04
 11            PI     .09     .07     .02     .01     .00     .00     .00     .00     .00     .00

 12            KK  KANUNA
 13            QO      31      32      32      34      36      38      41      47      60      97
 14            QO     177     337     443     547     675     770     842     878     902     950
 15            QO    1034    1125    1304    1620    2037    2222    2800    3350    4386    3966
 16            QO    3548    3024    2885    2766    2698    2630    2647    2630    2664    2681
 17            QO    2664    2664    2681    2698    2681    2664    2664    2614    2598    2550
 18            QO    2502    2425    2395    2350    2282    2222    2180    2121    2090    2038
 19            QO    1966    1918    1834    1788    1711    1680    1610    1570    1540    1473
 20            QO    1428    1401    1356    1312    1280    1232    1200    1153    1111    1076
 21            QO    1055     999     957     926     890     860     818     788     746     705
 22            QO     675     645     625     583     565     538     507     484     455     431
 23            QO     403     381     367     347     330     318     308     299     296     285
 24            PT    PRAT
 25            PW    1.00
 26            PR      TH
 27            PW    1.00
 28            BA    66.8      0.
 29            BF     31.    300.  1.0318
 30            UC     -8.    -18.
 31            LU     -1.    -.05
 32            ZZ
```

# COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

## STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 5 THROUGH 50)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.125 | | 21.26 | | | |
| COMPUTED HYDROGRAPH | 85934. | 1.993 | 1868. | 33.55 | 12.30 | 3352. | 30.00 |
| OBSERVED HYDROGRAPH | 85335. | 1.980 | 1855. | 34.55 | 13.29 | 4386. | 28.00 |
| DIFFERENCE | 599. | 0.014 | 13. | -0.99 | -0.99 | -1034. | 2.00 |
| PERCENT DIFFERENCE | 0.70 | | | | -7.48 | -23.57 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 382. | AVERAGE ABSOLUTE ERROR | 302. |
| OBJECTIVE FUNCTION | 430. | AVERAGE PERCENT ABSOLUTE ERROR | 21.23 |

## STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 110)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.125 | | 21.26 | | | |
| COMPUTED HYDROGRAPH | 130519. | 3.028 | 1187. | 46.01 | 24.76 | 3352. | 30.00 |
| OBSERVED HYDROGRAPH | 155294. | 3.602 | 1412. | 50.72 | 29.46 | 4386. | 28.00 |
| DIFFERENCE | -24775. | -0.575 | -225. | -4.71 | -4.71 | -1034. | 2.00 |
| PERCENT DIFFERENCE | -15.95 | | | | -15.98 | -23.57 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 433. | AVERAGE ABSOLUTE ERROR | 357. |
| OBJECTIVE FUNCTION | 491. | AVERAGE PERCENT ABSOLUTE ERROR | 29.52 |

UNIT HYDROGRAPH
144 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 127. | 481. | 946. | 1326. | 1458. | 1422. | 1370. | 1323. | 1271. | 1223. |
| 1160. | 1137. | 1095. | 1055. | 1016. | 979. | 943. | 908. | 875. | 843. |
| 812. | 782. | 753. | 726. | 699. | 674. | 649. | 625. | 602. | 580. |
| 559. | 538. | 518. | 499. | 481. | 463. | 446. | 430. | 414. | 399. |
| 384. | 370. | 357. | 344. | 331. | 319. | 307. | 296. | 285. | 275. |
| 265. | 255. | 246. | 237. | 228. | 219. | 211. | 204. | 196. | 189. |
| 182. | 175. | 169. | 163. | 157. | 151. | 146. | 140. | 135. | 130. |
| 125. | 121. | 116. | 112. | 108. | 104. | 100. | 96. | 93. | 90. |
| 86. | 83. | 80. | 77. | 74. | 72. | 69. | 66. | 64. | 62. |
| 59. | 57. | 55. | 53. | 51. | 49. | 47. | 46. | 44. | 42. |
| 41. | 39. | 38. | 37. | 35. | 34. | 33. | 31. | 30. | 29. |
| 28. | 27. | 26. | 25. | 24. | 23. | 22. | 22. | 21. | 20. |
| 19. | 19. | 18. | 17. | 17. | 16. | 15. | 15. | 14. | 14. |
| 13. | 13. | 12. | 12. | 11. | 11. | 11. | 10. | 10. | 10. |
| 9. | 9. | 8. | 8. | | | | | | |

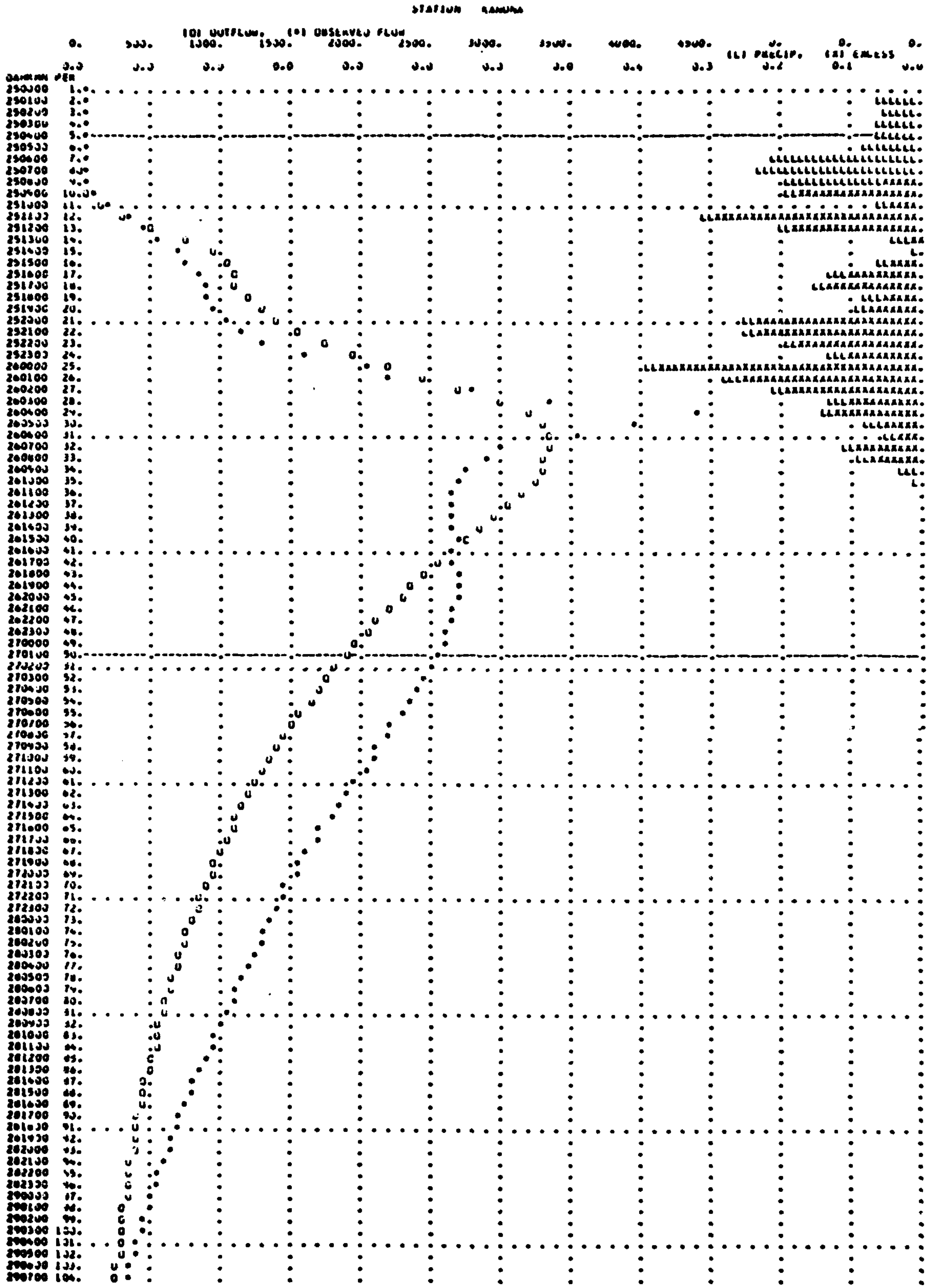
HYDROGRAPH AT STATION KANONA

| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|
| 25 | SEP | 0000 | 1 | 0.00 | 0.00 | 0.00 | 31. | 31. |
| 25 | SEP | 0100 | 2 | 0.06 | 0.06 | 0.00 | 30. | 32. |
| 25 | SEP | 0200 | 3 | 0.05 | 0.05 | 0.00 | 29. | 32. |
| 25 | SEP | 0300 | 4 | 0.06 | 0.06 | 0.00 | 28. | 34. |
| 25 | SEP | 0400 | 5 | 0.06 | 0.06 | 0.00 | 27. | 36. |
| 25 | SEP | 0500 | 6 | 0.08 | 0.08 | 0.00 | 27. | 38. |
| 25 | SEP | 0600 | 7 | 0.21 | 0.21 | 0.00 | 26. | 41. |
| 25 | SEP | 0700 | 8 | 0.23 | 0.23 | 0.00 | 25. | 47. |
| 25 | SEP | 0800 | 9 | 0.19 | 0.14 | 0.05 | 30. | 60. |
| 25 | SEP | 0900 | 10 | 0.19 | 0.02 | 0.17 | 88. | 97. |
| 25 | SEP | 1000 | 11 | 0.36 | 0.02 | 0.34 | 155. | 177. |
| 25 | SEP | 1100 | 12 | 0.31 | 0.02 | 0.29 | 301. | 337. |
| 25 | SEP | 1200 | 13 | 0.20 | 0.02 | 0.18 | 515. | 443. |
| 25 | SEP | 1300 | 14 | 0.34 | 0.02 | 0.31 | 750. | 567. |
| 25 | SEP | 1400 | 15 | 0.31 | 0.01 | 0.30 | 945. | 675. |
| 25 | SEP | 1500 | 16 | 0.06 | 0.02 | 0.04 | 1050. | 770. |
| 25 | SEP | 1600 | 17 | 0.13 | 0.02 | 0.10 | 1083. | 842. |
| 25 | SEP | 1700 | 18 | 0.15 | 0.02 | 0.13 | 1122. | 876. |
| 25 | SEP | 1800 | 19 | 0.08 | 0.02 | 0.05 | 1200. | 902. |
| 25 | SEP | 1900 | 20 | 0.09 | 0.02 | 0.07 | 1295. | 950. |
| 25 | SEP | 2000 | 21 | 0.25 | 0.02 | 0.23 | 1398. | 1034. |
| 25 | SEP | 2100 | 22 | 0.25 | 0.02 | 0.23 | 1538. | 1125. |
| 25 | SEP | 2200 | 23 | 0.19 | 0.02 | 0.17 | 1732. | 1304. |
| 25 | SEP | 2300 | 24 | 0.13 | 0.02 | 0.10 | 1959. | 1620. |
| 26 | SEP | 0000 | 25 | 0.39 | 0.02 | 0.37 | 2188. | 2037. |
| 26 | SEP | 0100 | 26 | 0.28 | 0.02 | 0.25 | 2438. | 2222. |
| 26 | SEP | 0200 | 27 | 0.21 | 0.02 | 0.19 | 2718. | 2803. |
| 26 | SEP | 0300 | 28 | 0.13 | 0.02 | 0.10 | 2994. | 3350. |
| 26 | SEP | 0400 | 29 | 0.14 | 0.02 | 0.12 | 3202. | 4388. |
| 26 | SEP | 0500 | 30 | 0.08 | 0.02 | 0.05 | 3314. | 3988. |
| 26 | SEP | 0600 | 31 | 0.05 | 0.02 | 0.03 | 3352. | 3548. |
| 26 | SEP | 0700 | 32 | 0.11 | 0.02 | 0.09 | 3346. | 3024. |
| 26 | SEP | 0800 | 33 | 0.09 | 0.02 | 0.07 | 3322. | 2883. |
| 26 | SEP | 0900 | 34 | 0.03 | 0.02 | 0.00 | 3290. | 2788. |
| 26 | SEP | 1000 | 35 | 0.01 | 0.01 | 0.00 | 3245. | 2698. |
| 26 | SEP | 1100 | 36 | 0.00 | 0.00 | 0.00 | 3172. | 2633. |
| 26 | SEP | 1200 | 37 | 0.00 | 0.00 | 0.00 | 3070. | 2647. |
| 26 | SEP | 1300 | 38 | 0.00 | 0.00 | 0.00 | 2959. | 2630. |
| 26 | SEP | 1400 | 39 | 0.00 | 0.00 | 0.00 | 2850. | 2664. |
| 26 | SEP | 1500 | 40 | 0.00 | 0.00 | 0.00 | 2748. | 2681. |
| 26 | SEP | 1600 | 41 | 0.00 | 0.00 | 0.00 | 2645. | 2604. |
| 26 | SEP | 1700 | 42 | 0.00 | 0.00 | 0.00 | 2548. | 2604. |
| 26 | SEP | 1800 | 43 | 0.00 | 0.00 | 0.00 | 2455. | 2681. |
| 26 | SEP | 1900 | 44 | 0.00 | 0.00 | 0.00 | 2365. | 2698. |
| 26 | SEP | 2000 | 45 | 0.00 | 0.00 | 0.00 | 2278. | 2681. |
| 26 | SEP | 2100 | 46 | 0.00 | 0.00 | 0.00 | 2194. | 2604. |
| 26 | SEP | 2200 | 47 | 0.00 | 0.00 | 0.00 | 2114. | 2664. |
| 26 | SEP | 2300 | 48 | 0.00 | 0.00 | 0.00 | 2036. | 2614. |
| 27 | SEP | 0000 | 49 | 0.00 | 0.00 | 0.00 | 1962. | 2593. |
| 27 | SEP | 0100 | 50 | 0.00 | 0.00 | 0.00 | 1890. | 2550. |
| 27 | SEP | 0200 | 51 | 0.00 | 0.00 | 0.00 | 1821. | 2502. |
| 27 | SEP | 0300 | 52 | 0.00 | 0.00 | 0.00 | 1754. | 2425. |
| 27 | SEP | 0400 | 53 | 0.00 | 0.00 | 0.00 | 1690. | 2395. |
| 27 | SEP | 0500 | 54 | 0.00 | 0.00 | 0.00 | 1628. | 2350. |
| 27 | SEP | 0600 | 55 | 0.00 | 0.00 | 0.00 | 1568. | 2282. |
| 27 | SEP | 0700 | 56 | 0.00 | 0.00 | 0.00 | 1510. | 2222. |
| 27 | SEP | 0800 | 57 | 0.00 | 0.00 | 0.00 | 1455. | 2180. |
| 27 | SEP | 0900 | 58 | 0.00 | 0.00 | 0.00 | 1402. | 2121. |
| 27 | SEP | 1000 | 59 | 0.00 | 0.00 | 0.00 | 1350. | 2090. |
| 27 | SEP | 1100 | 60 | 0.00 | 0.00 | 0.00 | 1301. | 2038. |
| 27 | SEP | 1200 | 61 | 0.00 | 0.00 | 0.00 | 1253. | 1988. |
| 27 | SEP | 1300 | 62 | 0.00 | 0.00 | 0.00 | 1207. | 1918. |
| 27 | SEP | 1400 | 63 | 0.00 | 0.00 | 0.00 | 1163. | 1834. |
| 27 | SEP | 1500 | 64 | 0.00 | 0.00 | 0.00 | 1120. | 1788. |
| 27 | SEP | 1600 | 65 | 0.00 | 0.00 | 0.00 | 1079. | 1711. |
| 27 | SEP | 1700 | 66 | 0.00 | 0.00 | 0.00 | 1040. | 1680. |
| 27 | SEP | 1800 | 67 | 0.00 | 0.00 | 0.00 | 1002. | 1610. |
| 27 | SEP | 1900 | 68 | 0.00 | 0.00 | 0.00 | 965. | 1570. |
| 27 | SEP | 2000 | 69 | 0.00 | 0.00 | 0.00 | 929. | 1540. |
| 27 | SEP | 2100 | 70 | 0.00 | 0.00 | 0.00 | 895. | 1473. |
| 27 | SEP | 2200 | 71 | 0.00 | 0.00 | 0.00 | 863. | 1426. |
| 27 | SEP | 2300 | 72 | 0.00 | 0.00 | 0.00 | 831. | 1461. |
| 28 | SEP | 0000 | 73 | 0.00 | 0.00 | 0.00 | 800. | 1356. |
| 28 | SEP | 0100 | 74 | 0.00 | 0.00 | 0.00 | 771. | 1312. |
| 28 | SEP | 0200 | 75 | 0.00 | 0.00 | 0.00 | 743. | 1280. |
| 28 | SEP | 0300 | 76 | 0.00 | 0.00 | 0.00 | 716. | 1232. |
| 28 | SEP | 0400 | 77 | 0.00 | 0.00 | 0.00 | 689. | 1200. |
| 28 | SEP | 0500 | 78 | 0.00 | 0.00 | 0.00 | 664. | 1153. |
| 28 | SEP | 0600 | 79 | 0.00 | 0.00 | 0.00 | 640. | 1111. |
| 28 | SEP | 0700 | 80 | 0.00 | 0.00 | 0.00 | 616. | 1076. |
| 28 | SEP | 0800 | 81 | 0.00 | 0.00 | 0.00 | 594. | 1055. |
| 28 | SEP | 0900 | 82 | 0.00 | 0.00 | 0.00 | 572. | 999. |
| 28 | SEP | 1000 | 83 | 0.00 | 0.00 | 0.00 | 551. | 957. |
| 28 | SEP | 1100 | 84 | 0.00 | 0.00 | 0.00 | 531. | 926. |
| 28 | SEP | 1200 | 85 | 0.00 | 0.00 | 0.00 | 511. | 890. |
| 28 | SEP | 1300 | 86 | 0.00 | 0.00 | 0.00 | 493. | 860. |
| 28 | SEP | 1400 | 87 | 0.00 | 0.00 | 0.00 | 475. | 818. |
| 28 | SEP | 1500 | 88 | 0.00 | 0.00 | 0.00 | 457. | 788. |
| 28 | SEP | 1600 | 89 | 0.00 | 0.00 | 0.00 | 440. | 748. |
| 28 | SEP | 1700 | 90 | 0.00 | 0.00 | 0.00 | 424. | 705. |
| 28 | SEP | 1800 | 91 | 0.00 | 0.00 | 0.00 | 409. | 675. |
| 28 | SEP | 1900 | 92 | 0.00 | 0.00 | 0.00 | 394. | 645. |
| 28 | SEP | 2000 | 93 | 0.00 | 0.00 | 0.00 | 379. | 625. |
| 28 | SEP | 2100 | 94 | 0.00 | 0.00 | 0.00 | 365. | 583. |
| 28 | SEP | 2200 | 95 | 0.00 | 0.00 | 0.00 | 352. | 565. |
| 28 | SEP | 2300 | 96 | 0.00 | 0.00 | 0.00 | 339. | 538. |
| 29 | SEP | 0000 | 97 | 0.00 | 0.00 | 0.00 | 327. | 507. |
| 29 | SEP | 0100 | 98 | 0.00 | 0.00 | 0.00 | 315. | 484. |
| 29 | SEP | 0200 | 99 | 0.00 | 0.00 | 0.00 | 303. | 455. |
| 29 | SEP | 0300 | 100 | 0.00 | 0.00 | 0.00 | 293. | 431. |
| 29 | SEP | 0400 | 101 | 0.00 | 0.00 | 0.00 | 284. | 403. |
| 29 | SEP | 0500 | 102 | 0.00 | 0.00 | 0.00 | 276. | 381. |
| 29 | SEP | 0600 | 103 | 0.00 | 0.00 | 0.00 | 267. | 367. |
| 29 | SEP | 0700 | 104 | 0.00 | 0.00 | 0.00 | 259. | 347. |
| 29 | SEP | 0800 | 105 | 0.00 | 0.00 | 0.00 | 251. | 330. |
| 29 | SEP | 0900 | 106 | 0.00 | 0.00 | 0.00 | 245. | 316. |
| 29 | SEP | 1000 | 107 | 0.00 | 0.00 | 0.00 | 238. | 308. |
| 29 | SEP | 1100 | 108 | 0.00 | 0.00 | 0.00 | 228. | 299. |
| 29 | SEP | 1200 | 109 | 0.00 | 0.00 | 0.00 | 221. | 290. |
| 29 | SEP | 1300 | 110 | 0.00 | 0.00 | 0.00 | 215. | 285. |

TOTAL RAINFALL = 4.59, TOTAL LOSS = 1.47, TOTAL EXCESS = 3.12

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 109.00-HR |
|---|---|---|---|---|---|---|
| 3352. | 30.00 | (CFS) | 3308. | 2783. | 1683. | 1198. |
| | | (INCHES) | 0.468 | 1.550 | 2.637 | 3.025 |
| | | (AC-FT) | 1640. | 5520. | 9999. | 10777. |

CUMULATIVE AREA = 66.80 SQ MI


STATION RAMONA
(O) OUTFLOW, (*) OBSERVED FLOW
0. 500. 1000. 1500. 2000. 2500. 3000. 3500. 4000. 4500.
(L) PRECIP, (X) EXCESS

```
                                       HEC-1 INPUT                                               PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        FIVE MILE CREEK    9-14-77
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3           IT      60 13SEP77    1500      50
  4           IO       1       2
  5           OU       6      32
  6           PG    BATH    2.39
  7           PG    PRAT    1.85
  8           PG      TH
  9           PI     .03     .01     .04     .07     .05     .03     .22     .35     .54     .16
 10           PI     .14     .05     .09     .05     .00     .00     .00     .00     .00     .00

 11           KK  KANUNA
 12           OU      11      11      11      11      11      11      11      12      23      35
 13           QU      94     166     357     388     371     371     427     480     515     534
 14           QO     520     497     484     471     463     443     423     403     381     353
 15           JU     327     299     271     245     216     192     172     156     143     132
 16           JO     123     117     109     103      99      94      91      87      86      86
 17           PT    PRAT    BATH
 18           PW     .87     .13
 19           PR      TH
 20           PW    1.00
 21           BA    66.8      0.
 22           BF     11.    110.  1.0318
 23           UC    -10.    -18.
 24           LU     -1.     -1.
 25           ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 6 THROUGH 32)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.347 | | 10.37 | | | |
| COMPUTED HYDROGRAPH | 8853. | 0.205 | 328. | 22.06 | 11.69 | 579. | 18.00 |
| OBSERVED HYDROGRAPH | 8859. | 0.206 | 328. | 21.81 | 11.44 | 534. | 19.00 |
| DIFFERENCE | -6. | -0.000 | -0. | 0.25 | 0.25 | 45. | -1.00 |
| PERCENT DIFFERENCE | -0.07 | | | | 2.19 | 8.46 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 52. | AVERAGE ABSOLUTE ERROR | 34. |
| OBJECTIVE FUNCTION | 54. | AVERAGE PERCENT ABSOLUTE ERROR | 15.60 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 50)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.347 | | 10.37 | | | |
| COMPUTED HYDROGRAPH | 12649. | 0.293 | 253. | 27.35 | 16.98 | 579. | 18.00 |
| OBSERVED HYDROGRAPH | 11436. | 0.265 | 229. | 25.64 | 15.27 | 534. | 19.00 |
| DIFFERENCE | 1213. | 0.028 | 24. | 1.72 | 1.71 | 45. | -1.00 |
| PERCENT DIFFERENCE | 10.61 | | | | 11.23 | 8.46 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 56. | AVERAGE ABSOLUTE ERROR | 43. |
| OBJECTIVE FUNCTION | 60. | AVERAGE PERCENT ABSOLUTE ERROR | 31.56 |

UNIT HYDROGRAPH
113 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 49. | 186. | 380. | 614. | 876. | 1137. | 1361. | 1533. | 1644. | 1669. |
| 1614. | 1537. | 1463. | 1393. | 1326. | 1263. | 1202. | 1144. | 1090. | 1037. |
| 988. | 940. | 895. | 852. | 811. | 772. | 735. | 700. | 667. | 635. |
| 604. | 575. | 548. | 521. | 496. | 472. | 450. | 428. | 408. | 388. |
| 370. | 352. | 335. | 319. | 304. | 289. | 275. | 262. | 249. | 237. |
| 226. | 215. | 205. | 195. | 186. | 177. | 168. | 160. | 153. | 145. |
| 138. | 132. | 125. | 119. | 114. | 108. | 103. | 98. | 93. | 89. |
| 85. | 81. | 77. | 73. | 69. | 66. | 63. | 60. | 57. | 54. |
| 52. | 49. | 47. | 45. | 43. | 40. | 39. | 37. | 35. | 33. |
| 32. | 30. | 29. | 27. | 26. | 25. | 24. | 22. | 21. | 20. |
| 19. | 18. | 17. | 17. | 16. | 15. | 14. | 14. | 13. | 12. |
| 12. | 11. | 11. | | | | | | | |

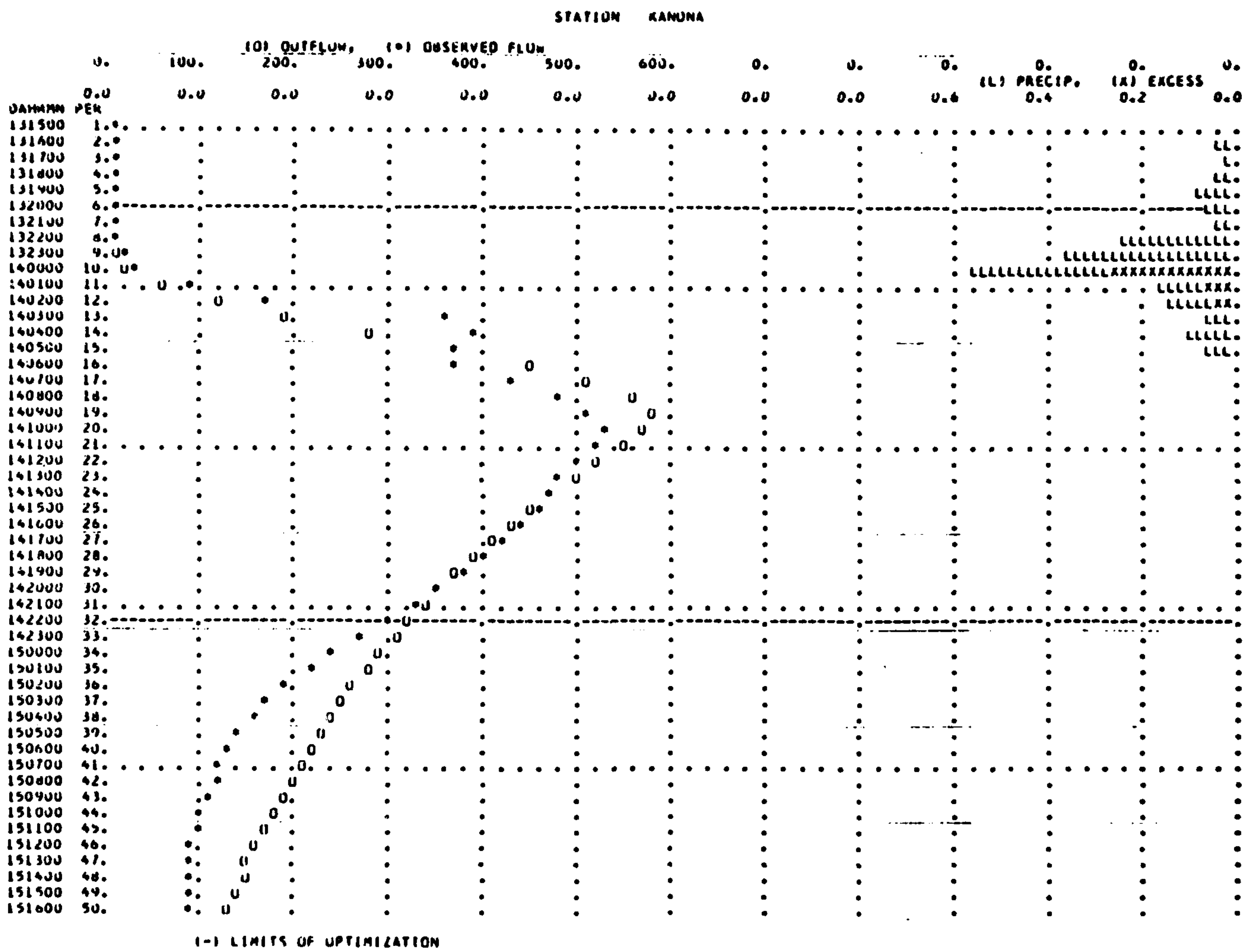
HYDROGRAPH AT STATION KANUNA

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 SEP 1500 | 1 | 0.00 | 0.00 | 0.00 | 11. | 11. | 14 SEP 1600 | 26 | 0.00 | 0.00 | 0.00 | 430. | 443. |
| 13 SEP 1600 | 2 | 0.03 | 0.03 | 0.00 | 11. | 11. | 14 SEP 1700 | 27 | 0.00 | 0.00 | 0.00 | 409. | 423. |
| 13 SEP 1700 | 3 | 0.01 | 0.01 | 0.00 | 10. | 11. | 14 SEP 1800 | 28 | 0.00 | 0.00 | 0.00 | 390. | 403. |
| 13 SEP 1800 | 4 | 0.04 | 0.04 | 0.00 | 10. | 11. | 14 SEP 1900 | 29 | 0.00 | 0.00 | 0.00 | 371. | 381. |
| 13 SEP 1900 | 5 | 0.07 | 0.07 | 0.00 | 10. | 11. | 14 SEP 2000 | 30 | 0.00 | 0.00 | 0.00 | 354. | 353. |
| 13 SEP 2000 | 6 | 0.05 | 0.05 | 0.00 | 9. | 11. | 14 SEP 2100 | 31 | 0.00 | 0.00 | 0.00 | 337. | 327. |
| 13 SEP 2100 | 7 | 0.03 | 0.03 | 0.00 | 9. | 11. | 14 SEP 2200 | 32 | 0.00 | 0.00 | 0.00 | 321. | 299. |
| 13 SEP 2200 | 8 | 0.23 | 0.23 | 0.00 | 9. | 12. | 14 SEP 2300 | 33 | 0.00 | 0.00 | 0.00 | 305. | 271. |
| 13 SEP 2300 | 9 | 0.37 | 0.37 | 0.00 | 9. | 23. | 15 SEP 0000 | 34 | 0.00 | 0.00 | 0.00 | 291. | 245. |
| 14 SEP 0000 | 10 | 0.57 | 0.31 | 0.26 | 21. | 35. | 15 SEP 0100 | 35 | 0.00 | 0.00 | 0.00 | 277. | 216. |
| 14 SEP 0100 | 11 | 0.17 | 0.11 | 0.06 | 58. | 94. | 15 SEP 0200 | 36 | 0.00 | 0.00 | 0.00 | 264. | 192. |
| 14 SEP 0200 | 12 | 0.15 | 0.11 | 0.04 | 117. | 166. | 15 SEP 0300 | 37 | 0.00 | 0.00 | 0.00 | 251. | 172. |
| 14 SEP 0300 | 13 | 0.05 | 0.05 | 0.00 | 192. | 357. | 15 SEP 0400 | 38 | 0.00 | 0.00 | 0.00 | 239. | 156. |
| 14 SEP 0400 | 14 | 0.09 | 0.09 | 0.00 | 279. | 388. | 15 SEP 0500 | 39 | 0.00 | 0.00 | 0.00 | 228. | 143. |
| 14 SEP 0500 | 15 | 0.05 | 0.05 | 0.00 | 368. | 371. | 15 SEP 0600 | 40 | 0.00 | 0.00 | 0.00 | 217. | 132. |
| 14 SEP 0600 | 16 | 0.00 | 0.00 | 0.00 | 449. | 371. | 15 SEP 0700 | 41 | 0.00 | 0.00 | 0.00 | 206. | 123. |
| 14 SEP 0700 | 17 | 0.00 | 0.00 | 0.00 | 515. | 427. | 15 SEP 0800 | 42 | 0.00 | 0.00 | 0.00 | 197. | 117. |
| 14 SEP 0800 | 18 | 0.00 | 0.00 | 0.00 | 561. | 480. | 15 SEP 0900 | 43 | 0.00 | 0.00 | 0.00 | 187. | 109. |
| 14 SEP 0900 | 19 | 0.00 | 0.00 | 0.00 | 579. | 515. | 15 SEP 1000 | 44 | 0.00 | 0.00 | 0.00 | 178. | 103. |
| 14 SEP 1000 | 20 | 0.00 | 0.00 | 0.00 | 570. | 534. | 15 SEP 1100 | 45 | 0.00 | 0.00 | 0.00 | 170. | 99. |
| 14 SEP 1100 | 21 | 0.00 | 0.00 | 0.00 | 548. | 520. | 15 SEP 1200 | 46 | 0.00 | 0.00 | 0.00 | 162. | 94. |
| 14 SEP 1200 | 22 | 0.00 | 0.00 | 0.00 | 523. | 497. | 15 SEP 1300 | 47 | 0.00 | 0.00 | 0.00 | 154. | 91. |
| 14 SEP 1300 | 23 | 0.00 | 0.00 | 0.00 | 498. | 484. | 15 SEP 1400 | 48 | 0.00 | 0.00 | 0.00 | 147. | 87. |
| 14 SEP 1400 | 24 | 0.00 | 0.00 | 0.00 | 474. | 471. | 15 SEP 1500 | 49 | 0.00 | 0.00 | 0.00 | 140. | 86. |
| 14 SEP 1500 | 25 | 0.00 | 0.00 | 0.00 | 452. | 463. | 15 SEP 1600 | 50 | 0.00 | 0.00 | 0.00 | 133. | 86. |

TOTAL RAINFALL = 1.92, TOTAL LOSS = 1.57, TOTAL EXCESS = 0.35

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 49.00-HR |
|---|---|---|---|---|---|---|
| 579. | 18.00 | (CFS) | 548. | 408. | 257. | 257. |
| | | (INCHES) | 0.076 | 0.227 | 0.292 | 0.292 |
| | | (AC-FT) | 272. | 810. | 1039. | 1039. |

CUMULATIVE AREA = 66.80 SQ MI


STATION KANONA
(O) OUTFLOW, (*) OBSERVED FLOW
0. 100. 200. 300. 400. 500. 600. 0. 0. 0. 0. 0. 0.
(L) PRECIP, (X) EXCESS
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.6 0.4 0.2 0.0
DAHMMN PER
(-) LIMITS OF OPTIMIZATION

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

          ID        FIVE MILE CREEK    9-25-77
          ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
          IT      60 24SEP77    1000      80
          IU       1       2
          OU       5      40
          PG    BATH    1.97
          PG    PRAT    2.14
          PG     HOR
          PI     .00     .00     .00     .00     .10     .20     .10     .30     .20     .00
          PI     .20     .10     .10     .10     .10     .20     .00     .00     .00     .00
          PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
          PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
          PI     .00     .10     .00     .00     .00     .00     .20     .10     .00     .00
          PI     .00     .00     .10     .00     .00     .00     .00     .00     .00     .00

          KK  KANONA
          QO     106     106     105     103     103     103     111     125     174     258
          QO     407     563     740     854     971    1176    1329    1491    1680    1777
          QO    1777    1690    1580    1530    1482    1473    1491    1491    1491    1491
          QO    1491    1482    1473    1464    1455    1437    1419    1392    1383    1347
          QO    1320    1296    1264    1240    1200    1184    1146    1111    1090    1055
          QO    1027     992     957     920     890     854     816     782     752     734
          QO     700     675     645     620     592     565     547     523     498     471
          QO     451     431     411     391     374     367     353     344     337     327
          PT    PRAT    BATH
          PW     .87     .13
          PR     HOR
          PW    1.00
          BA    66.8      0.
          BF    108.    200.  1.0318
          UC     -9.    -18.
          LU     -1.    -.05
          ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 5 THROUGH 40)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.002 | | 19.69 | | | |
| COMPUTED HYDROGRAPH | 41464. | 0.962 | 1152. | 25.83 | 6.15 | 1827. | 23.00 |
| OBSERVED HYDROGRAPH | 41721. | 0.968 | 1159. | 26.15 | 6.47 | 1777. | 19.00 |
| DIFFERENCE | -237. | -0.005 | -7. | -0.32 | -0.32 | 50. | 4.00 |
| PERCENT DIFFERENCE | -0.57 | | | | -4.98 | 2.82 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 154. | AVERAGE ABSOLUTE ERROR | 114. |
| OBJECTIVE FUNCTION | 163. | AVERAGE PERCENT ABSOLUTE ERROR | 9.09 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 80)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.002 | | 19.69 | | | |
| COMPUTED HYDROGRAPH | 76175. | 1.767 | 952. | 40.56 | 20.87 | 1827. | 23.00 |
| OBSERVED HYDROGRAPH | 72394. | 1.679 | 905. | 38.37 | 18.68 | 1777. | 19.00 |
| DIFFERENCE | 3781. | 0.088 | 47. | 2.19 | 2.19 | 50. | 4.00 |
| PERCENT DIFFERENCE | 5.22 | | | | 11.71 | 2.82 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 207. | AVERAGE ABSOLUTE ERROR | 172. |
| OBJECTIVE FUNCTION | 212. | AVERAGE PERCENT ABSOLUTE ERROR | 24.98 |

UNIT HYDROGRAPH
148 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 31. | 117. | 243. | 394. | 564. | 748. | 924. | 1073. | 1192. | 1275. |
| 1311. | 1291. | 1246. | 1194. | 1154. | 1112. | 1071. | 1032. | 994. | 958. |
| 923. | 889. | 856. | 825. | 795. | 766. | 737. | 710. | 684. | 659. |
| 635. | 612. | 590. | 568. | 547. | 527. | 508. | 489. | 471. | 454. |
| 437. | 421. | 406. | 391. | 377. | 363. | 350. | 337. | 324. | 313. |
| 301. | 290. | 279. | 269. | 259. | 250. | 241. | 232. | 223. | 215. |
| 207. | 200. | 192. | 185. | 179. | 172. | 166. | 160. | 154. | 148. |
| 143. | 137. | 132. | 128. | 123. | 118. | 114. | 110. | 106. | 102. |
| 98. | 95. | 91. | 88. | 85. | 82. | 79. | 76. | 73. | 70. |
| 68. | 65. | 63. | 60. | 58. | 56. | 54. | 52. | 50. | 48. |
| 47. | 45. | 43. | 42. | 40. | 39. | 37. | 36. | 35. | 33. |
| 32. | 31. | 30. | 29. | 28. | 27. | 26. | 25. | 24. | 23. |
| 22. | 21. | 20. | 20. | 19. | 18. | 18. | 17. | 16. | 16. |
| 15. | 15. | 14. | 14. | 13. | 13. | 12. | 12. | 11. | 11. |
| 10. | 10. | 10. | 9. | 9. | 9. | 8. | 8. | | |

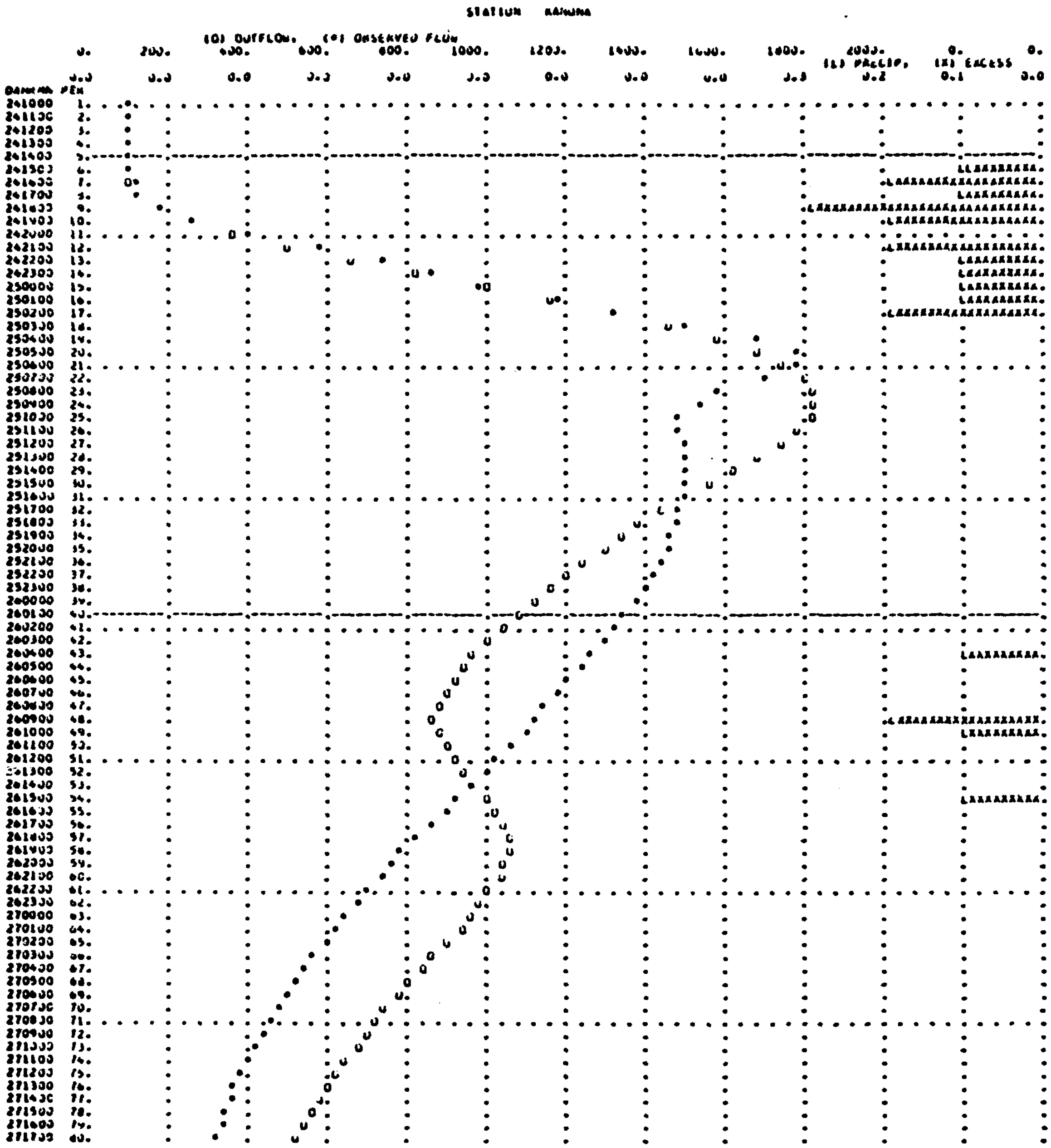
HYDROGRAPH AT STATION KANONA

| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|
| 24 | SEP | 1000 | 1 | 0.00 | 0.00 | 0.00 | 108. | 106. |
| 24 | SEP | 1100 | 2 | 0.00 | 0.00 | 0.00 | 105. | 106. |
| 24 | SEP | 1200 | 3 | 0.00 | 0.00 | 0.00 | 101. | 105. |
| 24 | SEP | 1300 | 4 | 0.00 | 0.00 | 0.00 | 98. | 103. |
| 24 | SEP | 1400 | 5 | 0.00 | 0.00 | 0.00 | 95. | 103. |
| 24 | SEP | 1500 | 6 | 0.10 | 0.02 | 0.08 | 95. | 103. |
| 24 | SEP | 1600 | 7 | 0.19 | 0.01 | 0.19 | 104. | 111. |
| 24 | SEP | 1700 | 8 | 0.10 | 0.01 | 0.09 | 130. | 125. |
| 24 | SEP | 1800 | 9 | 0.29 | 0.01 | 0.28 | 178. | 174. |
| 24 | SEP | 1900 | 10 | 0.19 | 0.01 | 0.19 | 258. | 258. |
| 24 | SEP | 2000 | 11 | 0.00 | 0.00 | 0.00 | 366. | 407. |
| 24 | SEP | 2100 | 12 | 0.19 | 0.01 | 0.19 | 498. | 583. |
| 24 | SEP | 2200 | 13 | 0.10 | 0.01 | 0.09 | 651. | 743. |
| 24 | SEP | 2300 | 14 | 0.10 | 0.01 | 0.09 | 818. | 854. |
| 25 | SEP | 0000 | 15 | 0.10 | 0.01 | 0.09 | 991. | 971. |
| 25 | SEP | 0100 | 16 | 0.10 | 0.01 | 0.09 | 1160. | 1176. |
| 25 | SEP | 0200 | 17 | 0.19 | 0.01 | 0.19 | 1319. | 1329. |
| 25 | SEP | 0300 | 18 | 0.00 | 0.00 | 0.00 | 1464. | 1491. |
| 25 | SEP | 0400 | 19 | 0.00 | 0.00 | 0.00 | 1585. | 1680. |
| 25 | SEP | 0500 | 20 | 0.00 | 0.00 | 0.00 | 1679. | 1777. |
| 25 | SEP | 0600 | 21 | 0.00 | 0.00 | 0.00 | 1748. | 1777. |
| 25 | SEP | 0700 | 22 | 0.00 | 0.00 | 0.00 | 1798. | 1690. |
| 25 | SEP | 0800 | 23 | 0.00 | 0.00 | 0.00 | 1824. | 1580. |
| 25 | SEP | 0900 | 24 | 0.00 | 0.00 | 0.00 | 1827. | 1530. |
| 25 | SEP | 1000 | 25 | 0.00 | 0.00 | 0.00 | 1811. | 1482. |
| 25 | SEP | 1100 | 26 | 0.00 | 0.00 | 0.00 | 1778. | 1473. |
| 25 | SEP | 1200 | 27 | 0.00 | 0.00 | 0.00 | 1731. | 1491. |
| 25 | SEP | 1300 | 28 | 0.00 | 0.00 | 0.00 | 1673. | 1491. |
| 25 | SEP | 1400 | 29 | 0.00 | 0.00 | 0.00 | 1612. | 1491. |
| 25 | SEP | 1500 | 30 | 0.00 | 0.00 | 0.00 | 1554. | 1491. |
| 25 | SEP | 1600 | 31 | 0.00 | 0.00 | 0.00 | 1497. | 1491. |
| 25 | SEP | 1700 | 32 | 0.00 | 0.00 | 0.00 | 1442. | 1482. |
| 25 | SEP | 1800 | 33 | 0.00 | 0.00 | 0.00 | 1390. | 1473. |
| 25 | SEP | 1900 | 34 | 0.00 | 0.00 | 0.00 | 1339. | 1464. |
| 25 | SEP | 2000 | 35 | 0.00 | 0.00 | 0.00 | 1290. | 1455. |
| 25 | SEP | 2100 | 36 | 0.00 | 0.00 | 0.00 | 1243. | 1437. |
| 25 | SEP | 2200 | 37 | 0.00 | 0.00 | 0.00 | 1198. | 1419. |
| 25 | SEP | 2300 | 38 | 0.00 | 0.00 | 0.00 | 1154. | 1392. |
| 26 | SEP | 0000 | 39 | 0.00 | 0.00 | 0.00 | 1112. | 1363. |
| 26 | SEP | 0100 | 40 | 0.00 | 0.00 | 0.00 | 1071. | 1347. |
| 26 | SEP | 0200 | 41 | 0.00 | 0.00 | 0.00 | 1032. | 1320. |
| 26 | SEP | 0300 | 42 | 0.00 | 0.00 | 0.00 | 995. | 1298. |
| 26 | SEP | 0400 | 43 | 0.10 | 0.01 | 0.09 | 961. | 1264. |
| 26 | SEP | 0500 | 44 | 0.00 | 0.00 | 0.00 | 934. | 1240. |
| 26 | SEP | 0600 | 45 | 0.00 | 0.00 | 0.00 | 912. | 1200. |
| 26 | SEP | 0700 | 46 | 0.00 | 0.00 | 0.00 | 893. | 1184. |
| 26 | SEP | 0800 | 47 | 0.00 | 0.00 | 0.00 | 877. | 1146. |
| 26 | SEP | 0900 | 48 | 0.19 | 0.01 | 0.19 | 869. | 1111. |
| 26 | SEP | 1000 | 49 | 0.10 | 0.01 | 0.09 | 874. | 1090. |
| 26 | SEP | 1100 | 50 | 0.00 | 0.00 | 0.00 | 891. | 1055. |
| 26 | SEP | 1200 | 51 | 0.00 | 0.00 | 0.00 | 914. | 1027. |
| 26 | SEP | 1300 | 52 | 0.00 | 0.00 | 0.00 | 940. | 992. |
| 26 | SEP | 1400 | 53 | 0.00 | 0.00 | 0.00 | 968. | 957. |
| 26 | SEP | 1500 | 54 | 0.10 | 0.01 | 0.09 | 994. | 920. |
| 26 | SEP | 1600 | 55 | 0.00 | 0.00 | 0.00 | 1017. | 890. |
| 26 | SEP | 1700 | 56 | 0.00 | 0.00 | 0.00 | 1038. | 854. |
| 26 | SEP | 1800 | 57 | 0.00 | 0.00 | 0.00 | 1052. | 818. |
| 26 | SEP | 1900 | 58 | 0.00 | 0.00 | 0.00 | 1057. | 782. |
| 26 | SEP | 2000 | 59 | 0.00 | 0.00 | 0.00 | 1049. | 752. |
| 26 | SEP | 2100 | 60 | 0.00 | 0.00 | 0.00 | 1031. | 734. |
| 26 | SEP | 2200 | 61 | 0.00 | 0.00 | 0.00 | 1010. | 700. |
| 26 | SEP | 2300 | 62 | 0.00 | 0.00 | 0.00 | 987. | 675. |
| 27 | SEP | 0000 | 63 | 0.00 | 0.00 | 0.00 | 962. | 645. |
| 27 | SEP | 0100 | 64 | 0.00 | 0.00 | 0.00 | 935. | 620. |
| 27 | SEP | 0200 | 65 | 0.00 | 0.00 | 0.00 | 903. | 592. |
| 27 | SEP | 0300 | 66 | 0.00 | 0.00 | 0.00 | 870. | 565. |
| 27 | SEP | 0400 | 67 | 0.00 | 0.00 | 0.00 | 838. | 547. |
| 27 | SEP | 0500 | 68 | 0.00 | 0.00 | 0.00 | 808. | 523. |
| 27 | SEP | 0600 | 69 | 0.00 | 0.00 | 0.00 | 778. | 498. |
| 27 | SEP | 0700 | 70 | 0.00 | 0.00 | 0.00 | 750. | 471. |
| 27 | SEP | 0800 | 71 | 0.00 | 0.00 | 0.00 | 722. | 451. |
| 27 | SEP | 0900 | 72 | 0.00 | 0.00 | 0.00 | 696. | 431. |
| 27 | SEP | 1000 | 73 | 0.00 | 0.00 | 0.00 | 670. | 411. |
| 27 | SEP | 1100 | 74 | 0.00 | 0.00 | 0.00 | 646. | 391. |
| 27 | SEP | 1200 | 75 | 0.00 | 0.00 | 0.00 | 622. | 374. |
| 27 | SEP | 1300 | 76 | 0.00 | 0.00 | 0.00 | 600. | 367. |
| 27 | SEP | 1400 | 77 | 0.00 | 0.00 | 0.00 | 578. | 355. |
| 27 | SEP | 1500 | 78 | 0.00 | 0.00 | 0.00 | 557. | 349. |
| 27 | SEP | 1600 | 79 | 0.00 | 0.00 | 0.00 | 536. | 337. |
| 27 | SEP | 1700 | 80 | 0.00 | 0.00 | 0.00 | 517. | 327. |

TOTAL RAINFALL = 2.12, TOTAL LOSS = 0.12, TOTAL EXCESS = 2.00

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 79.00-HR |
|---|---|---|---|---|---|---|
| 1827. | 23.00 | (CFS) | 1798. | 1508. | 1044. | 960. |
| | | (INCHES) | 0.250 | 0.839 | 1.763 | 1.760 |
| | | (AC-FT) | 891. | 2990. | 6210. | 6270. |

CUMULATIVE AREA = 66.60 SQ MI


STATION KAHUNA
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS

```
                                   HEC-1 INPUT                                          PAGE  1

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID        NEWTOWN CREEK 09-26-75
  2         ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3         IT      60 24SEP75    1800     114
  4         IO       1       2
  5         QU       5      58
  6         PG      EL    4.75
  7         PG      SP    4.55
  8         PG      AF
  9         PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .03
 10         PI     .02     .10     .15     .00     .19     .11     .10     .20     .09     .06
 11         PI     .03     .16     .07     .19     .10     .14     .04     .07     .09     .10
 12         PI     .21     .35     .40     .15     .30     .15     .20     .15     .01     .17
 13         PI     .02     .00     .00     .00     .00     .00     .00     .00     .00     .00

 14         KK  ELMIRA
 15         QO     256     250     242     232     224     216     206     206     202     206
 16         QO     216     224     238     281     367     468     637     951    1173    1290
 17         QO    1383    1422    1434    1437    1434    1413    1422    1473    1530    1578
 18         QO    1635    1722    1797    1833    1857    1905    1965    2160    2498    2939
 19         QO    3224    3525    3725    3860    3932    3938    3896    3842    3775    3700
 20         QO    3640    3560    3430    3255    3062    2838    2614    2391    2174    1971
 21         QO    1785    1611    1455    1320    1200    1095    1002     921     855     805
 22         QO     763     729     698     682     676     665     651     637     623     604
 23         QO     589     573     558     545     530     513     495     484     463     442
 24         QO     420     398     380     367     354     345     336     327     318     310
 25         QO     303     294     288     283     279     272     270     266     262     256
 26         QO     250     246     242     238       0       0       0       0       0       0
 27         PT      EL      SP      AF
 28         PW     .47     .06     .47
 29         PR      AF
 30         PW    1.00
 31         BA    77.5      0.
 32         BF    256.    295.  1.0346
 33         UC    -10.    -16.
 34         LU     -.6    -.08
 35         ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 5 THROUGH 58)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.029 | | 29.50 | | | |
| COMPUTED HYDROGRAPH | 104121. | 2.082 | 1928. | 42.25 | 12.75 | 4225. | 45.00 |
| OBSERVED HYDROGRAPH | 104121. | 2.082 | 1928. | 40.92 | 11.43 | 3938. | 45.00 |
| DIFFERENCE | 0. | 0.000 | 0. | 1.32 | 1.32 | 287. | 0.00 |
| PERCENT DIFFERENCE | 0.00 | | | | 11.56 | 7.29 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 317. | AVERAGE ABSOLUTE ERROR | 229. |
| OBJECTIVE FUNCTION | 311. | AVERAGE PERCENT ABSOLUTE ERROR | 16.83 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 114)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.029 | | 29.50 | | | |
| COMPUTED HYDROGRAPH | 155692. | 3.113 | 1366. | 52.75 | 23.25 | 4225. | 45.00 |
| OBSERVED HYDROGRAPH | 140523. | 2.810 | 1233. | 49.67 | 20.18 | 3938. | 45.00 |
| DIFFERENCE | 15169. | 0.303 | 133. | 3.07 | 3.07 | 287. | 0.00 |
| PERCENT DIFFERENCE | 10.79 | | | | 15.23 | 7.29 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 342. | AVERAGE ABSOLUTE ERROR | 244. |
| OBJECTIVE FUNCTION | 367. | AVERAGE PERCENT ABSOLUTE ERROR | 26.99 |

UNIT HYDROGRAPH
116 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 38. | 144. | 297. | 479. | 684. | 907. | 1137. | 1349. | 1526. | 1666. |
| 1765. | 1817. | 1830. | 1727. | 1645. | 1567. | 1493. | 1422. | 1354. | 1290. |
| 1229. | 1171. | 1115. | 1062. | 1012. | 964. | 918. | 875. | 833. | 794. |
| 756. | 720. | 686. | 653. | 622. | 593. | 565. | 538. | 512. | 488. |
| 465. | 443. | 422. | 402. | 383. | 365. | 347. | 331. | 315. | 300. |
| 286. | 272. | 259. | 247. | 235. | 224. | 214. | 204. | 194. | 185. |
| 176. | 168. | 160. | 152. | 145. | 138. | 131. | 125. | 119. | 114. |
| 108. | 103. | 98. | 94. | 89. | 85. | 81. | 77. | 73. | 70. |
| 67. | 63. | 60. | 58. | 55. | 52. | 50. | 47. | 45. | 43. |
| 41. | 39. | 37. | 35. | 34. | 32. | 31. | 29. | 28. | 26. |
| 25. | 24. | 23. | 22. | 21. | 20. | 19. | 18. | 17. | 16. |
| 15. | 15. | 14. | 13. | 13. | 12. | | | | |

HYDROGRAPH AT STATION ELMIRA

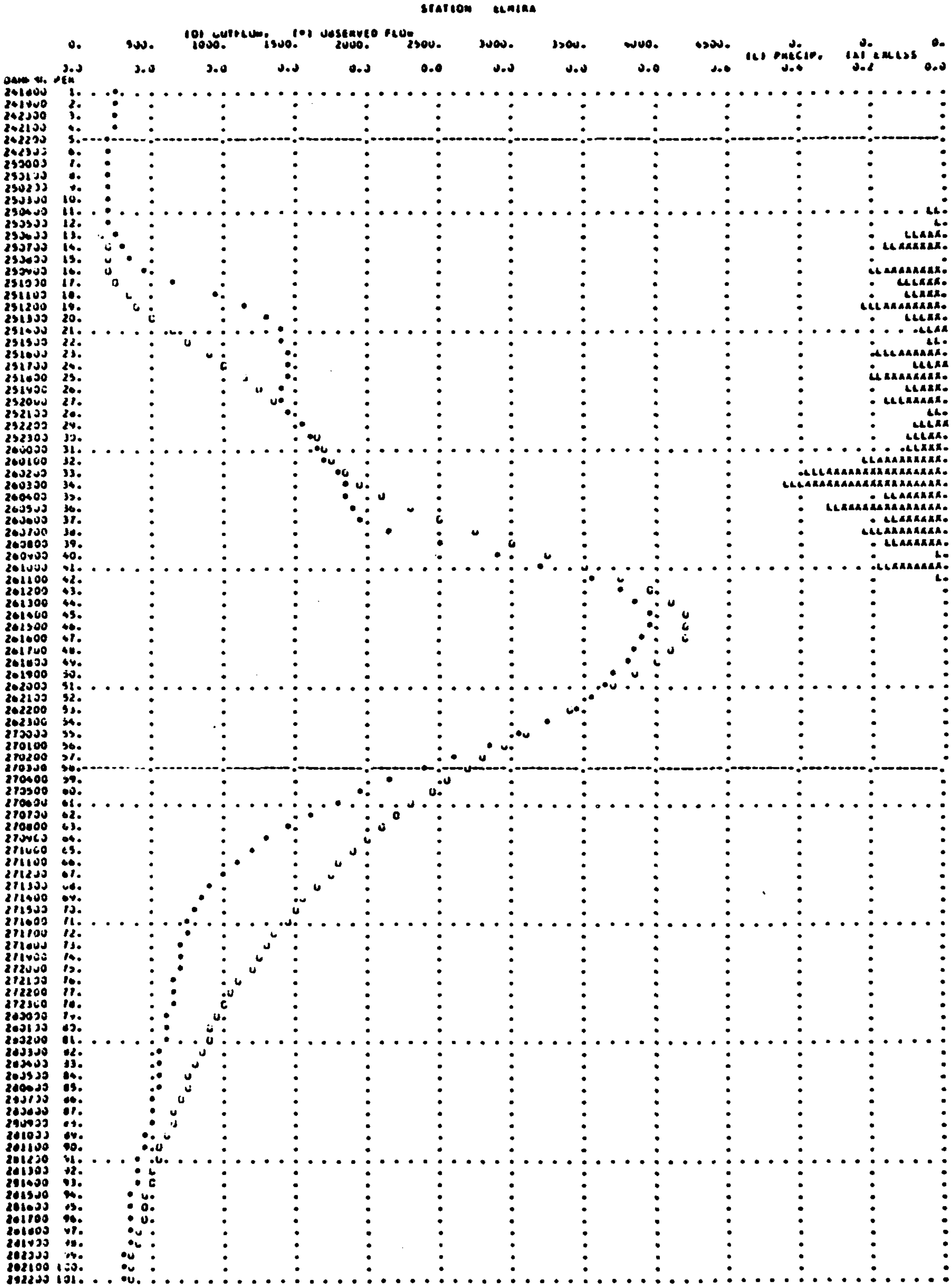
| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 24 SEP 1800 | 1 | 0.00 | 0.00 | 0.00 | 256. | 256. |
| 24 SEP 1900 | 2 | 0.00 | 0.00 | 0.00 | 247. | 250. |
| 24 SEP 2000 | 3 | 0.00 | 0.00 | 0.00 | 239. | 242. |
| 24 SEP 2100 | 4 | 0.00 | 0.00 | 0.00 | 231. | 232. |
| 24 SEP 2200 | 5 | 0.00 | 0.00 | 0.00 | 223. | 224. |
| 24 SEP 2300 | 6 | 0.00 | 0.00 | 0.00 | 216. | 216. |
| 25 SEP 0000 | 7 | 0.00 | 0.00 | 0.00 | 209. | 208. |
| 25 SEP 0100 | 8 | 0.00 | 0.00 | 0.00 | 202. | 206. |
| 25 SEP 0200 | 9 | 0.00 | 0.00 | 0.00 | 195. | 202. |
| 25 SEP 0300 | 10 | 0.00 | 0.00 | 0.00 | 188. | 206. |
| 25 SEP 0400 | 11 | 0.03 | 0.03 | 0.00 | 182. | 216. |
| 25 SEP 0500 | 12 | 0.02 | 0.02 | 0.00 | 176. | 224. |
| 25 SEP 0600 | 13 | 0.11 | 0.05 | 0.06 | 172. | 238. |
| 25 SEP 0700 | 14 | 0.16 | 0.05 | 0.11 | 177. | 281. |
| 25 SEP 0800 | 15 | 0.00 | 0.00 | 0.00 | 192. | 367. |
| 25 SEP 0900 | 16 | 0.20 | 0.05 | 0.15 | 219. | 468. |
| 25 SEP 1000 | 17 | 0.12 | 0.05 | 0.07 | 265. | 637. |
| 25 SEP 1100 | 18 | 0.11 | 0.05 | 0.06 | 328. | 951. |
| 25 SEP 1200 | 19 | 0.22 | 0.05 | 0.16 | 411. | 1173. |
| 25 SEP 1300 | 20 | 0.10 | 0.05 | 0.05 | 516. | 1293. |
| 25 SEP 1400 | 21 | 0.06 | 0.05 | 0.01 | 635. | 1383. |
| 25 SEP 1500 | 22 | 0.03 | 0.03 | 0.00 | 757. | 1422. |
| 25 SEP 1600 | 23 | 0.17 | 0.05 | 0.12 | 883. | 1434. |
| 25 SEP 1700 | 24 | 0.06 | 0.05 | 0.02 | 1010. | 1437. |
| 25 SEP 1800 | 25 | 0.20 | 0.05 | 0.15 | 1134. | 1434. |
| 25 SEP 1900 | 26 | 0.11 | 0.05 | 0.06 | 1251. | 1413. |
| 25 SEP 2000 | 27 | 0.15 | 0.05 | 0.10 | 1362. | 1422. |
| 25 SEP 2100 | 28 | 0.04 | 0.04 | 0.00 | 1464. | 1473. |
| 25 SEP 2200 | 29 | 0.08 | 0.05 | 0.02 | 1555. | 1530. |
| 25 SEP 2300 | 30 | 0.10 | 0.05 | 0.05 | 1636. | 1578. |
| 26 SEP 0000 | 31 | 0.11 | 0.05 | 0.06 | 1706. | 1635. |
| 26 SEP 0100 | 32 | 0.23 | 0.05 | 0.17 | 1772. | 1722. |
| 26 SEP 0200 | 33 | 0.38 | 0.05 | 0.33 | 1851. | 1797. |
| 26 SEP 0300 | 34 | 0.43 | 0.05 | 0.38 | 1964. | 1833. |
| 26 SEP 0400 | 35 | 0.16 | 0.05 | 0.11 | 2139. | 1857. |
| 26 SEP 0500 | 36 | 0.32 | 0.05 | 0.27 | 2288. | 1905. |
| 26 SEP 0600 | 37 | 0.16 | 0.05 | 0.11 | 2493. | 1965. |
| 26 SEP 0700 | 38 | 0.22 | 0.05 | 0.16 | 2726. | 2163. |
| 26 SEP 0800 | 39 | 0.16 | 0.05 | 0.11 | 2983. | 2498. |
| 26 SEP 0900 | 40 | 0.01 | 0.01 | 0.00 | 3250. | 2909. |
| 26 SEP 1000 | 41 | 0.18 | 0.05 | 0.13 | 3511. | 3224. |
| 27 SEP 0200 | 57 | 0.00 | 0.00 | 0.00 | 2839. | 2614. |

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 27 SEP 0300 | 58 | 0.00 | 0.00 | 0.00 | 2676. | 2391. |
| 27 SEP 0400 | 59 | 0.00 | 0.00 | 0.00 | 2550. | 2174. |
| 27 SEP 0500 | 60 | 0.00 | 0.00 | 0.00 | 2429. | 1971. |
| 27 SEP 0600 | 61 | 0.00 | 0.00 | 0.00 | 2314. | 1785. |
| 27 SEP 0700 | 62 | 0.00 | 0.00 | 0.00 | 2205. | 1611. |
| 27 SEP 0800 | 63 | 0.00 | 0.00 | 0.00 | 2101. | 1455. |
| 27 SEP 0900 | 64 | 0.00 | 0.00 | 0.00 | 2002. | 1320. |
| 27 SEP 1000 | 65 | 0.00 | 0.00 | 0.00 | 1907. | 1200. |
| 27 SEP 1100 | 66 | 0.00 | 0.00 | 0.00 | 1817. | 1095. |
| 27 SEP 1200 | 67 | 0.00 | 0.00 | 0.00 | 1731. | 1002. |
| 27 SEP 1300 | 68 | 0.00 | 0.00 | 0.00 | 1649. | 921. |
| 27 SEP 1400 | 69 | 0.00 | 0.00 | 0.00 | 1572. | 855. |
| 27 SEP 1500 | 70 | 0.00 | 0.00 | 0.00 | 1497. | 805. |
| 27 SEP 1600 | 71 | 0.00 | 0.00 | 0.00 | 1427. | 763. |
| 27 SEP 1700 | 72 | 0.00 | 0.00 | 0.00 | 1359. | 729. |
| 27 SEP 1800 | 73 | 0.00 | 0.00 | 0.00 | 1295. | 698. |
| 27 SEP 1900 | 74 | 0.00 | 0.00 | 0.00 | 1234. | 682. |
| 27 SEP 2000 | 75 | 0.00 | 0.00 | 0.00 | 1176. | 676. |
| 27 SEP 2100 | 76 | 0.00 | 0.00 | 0.00 | 1120. | 665. |
| 27 SEP 2200 | 77 | 0.00 | 0.00 | 0.00 | 1067. | 651. |
| 27 SEP 2300 | 78 | 0.00 | 0.00 | 0.00 | 1017. | 637. |
| 28 SEP 0000 | 79 | 0.00 | 0.00 | 0.00 | 969. | 623. |
| 28 SEP 0100 | 80 | 0.00 | 0.00 | 0.00 | 923. | 604. |
| 28 SEP 0200 | 81 | 0.00 | 0.00 | 0.00 | 880. | 589. |
| 28 SEP 0300 | 82 | 0.00 | 0.00 | 0.00 | 838. | 573. |
| 28 SEP 0400 | 83 | 0.00 | 0.00 | 0.00 | 799. | 558. |
| 28 SEP 0500 | 84 | 0.00 | 0.00 | 0.00 | 761. | 545. |
| 28 SEP 0600 | 85 | 0.00 | 0.00 | 0.00 | 725. | 530. |
| 28 SEP 0700 | 86 | 0.00 | 0.00 | 0.00 | 691. | 513. |
| 28 SEP 0800 | 87 | 0.00 | 0.00 | 0.00 | 658. | 499. |
| 28 SEP 0900 | 88 | 0.00 | 0.00 | 0.00 | 627. | 484. |
| 28 SEP 1000 | 89 | 0.00 | 0.00 | 0.00 | 598. | 463. |
| 28 SEP 1100 | 90 | 0.00 | 0.00 | 0.00 | 570. | 442. |
| 28 SEP 1200 | 91 | 0.00 | 0.00 | 0.00 | 543. | 420. |
| 28 SEP 1300 | 92 | 0.00 | 0.00 | 0.00 | 517. | 398. |
| 28 SEP 1400 | 93 | 0.00 | 0.00 | 0.00 | 493. | 380. |
| 28 SEP 1500 | 94 | 0.00 | 0.00 | 0.00 | 470. | 367. |
| 28 SEP 1600 | 95 | 0.00 | 0.00 | 0.00 | 447. | 354. |
| 28 SEP 1700 | 96 | 0.00 | 0.00 | 0.00 | 426. | 345. |
| 28 SEP 1800 | 97 | 0.00 | 0.00 | 0.00 | 406. | 336. |
| 28 SEP 1900 | 98 | 0.00 | 0.00 | 0.00 | 387. | 327. |
| 29 SEP 1100 | 114 | 0.00 | 0.00 | 0.00 | 207. | 238. |

TOTAL RAINFALL = 4.46, TOTAL LOSS = 1.43, TOTAL EXCESS = 3.03

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 113.00-HR |
|---|---|---|---|---|---|---|
| 4225. | 45.00 | (CFS) | 4139. | 3438. | 1997. | 1376. |
| | | (INCHES) | 0.497 | 1.035 | 2.476 | 3.108 |
| | | (AC-FT) | 2052. | 6759. | 11886. | 12848. |

CUMULATIVE AREA = 77.50 SQ MI


STATION ELMIRA
(O) OUTFLOW, (*) OBSERVED FLOW
0. 500. 1000. 1500. 2000. 2500. 3000. 3500. 4000. 4500. 0. 0. 0.
(L) PRECIP, (X) EXCESS

```
                                          HEC-1 INPUT                                           PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1          ID        NEWTOWN CREEK 10-09-76
   2          ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
   3          IT      60 07OCT76    1300      95
   4          IO       1       2
   5          OU      42      65
   6          PG      EL    3.44
   7          PG      SP    3.38
   8          PG      AF
   9          PI     .00     .00     .00     .00     .10     .10     .00     .00     .00     .10
  10          PI     .20     .30     .00     .00     .10     .10     .00     .00     .00     .00
  11          PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
  12          PI     .00     .10     .00     .00     .00     .00     .10     .10     .10     .10
  13          PI     .10     .10     .10     .10     .20     .30     .40     .20     .00     .20
  14          PI     .10     .10     .00     .10     .00     .10     .00     .00     .00     .00

                                                              ERROR
  15          KK  ELMIRA                                      32 not 320
  16          QO      32      32      32      32      32      32      32      33      34      34
  17          QO      35      37      44      46      46      55      55      60      64      64
  18          QO      76     110     156     168     167     159     152     142     136     130
  19          QO     123     118     116     110     108     103     100      99      99     100
  20          QO     104     115     138     178     220     463     670     865    1055    1205
  21          QO    1288    1435    1555    1765    1940    2042    2105    2100    2055    1985
  22          QO    1900    1803    1678    1505    1313    1120     965     865     792     740
  23          QO     692     652     620     593     555     530     494     455     448     433
  24          QO     402     376     358     342     330     318     306     298     290     282
  25          QO     272     268     260     252     248       0       0       0       0       0
  26          PT      EL      SP      AF
  27          PW     .47     .06     .47
  28          PR      AF
  29          PW    1.00
  30          BA    77.5      0.
  31          BF     32.    320.  1.0346
  32          UC     -9.    -12.
  33          LU     -1.     -1.
  34          ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 42 THROUGH 65)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.388 | | 38.62 | | | |
| COMPUTED HYDROGRAPH | 31377. | 0.627 | 1307. | 56.52 | 17.90 | 2155. | 56.00 |
| OBSERVED HYDROGRAPH | 31378. | 0.627 | 1307. | 56.44 | 17.83 | 2105. | 56.00 |
| DIFFERENCE | -1. | -0.000 | -0. | 0.07 | 0.07 | 50. | 0.00 |
| PERCENT DIFFERENCE | -0.00 | | | | 0.41 | 2.39 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 162. | AVERAGE ABSOLUTE ERROR | 128. |
| OBJECTIVE FUNCTION | 149. | AVERAGE PERCENT ABSOLUTE ERROR | 28.90 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 95)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.388 | | 38.62 | | | |
| COMPUTED HYDROGRAPH | 66285. | 1.325 | 698. | 56.02 | 17.40 | 2155. | 56.00 |
| OBSERVED HYDROGRAPH | 49627. | 0.992 | 522. | 60.00 | 21.38 | 2105. | 56.00 |
| DIFFERENCE | 16658. | 0.333 | 175. | -3.98 | -3.98 | 50. | 0.00 |
| PERCENT DIFFERENCE | 33.57 | | | | -18.60 | 2.39 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 153. | AVERAGE ABSOLUTE ERROR | 95. |
| OBJECTIVE FUNCTION | 183. | AVERAGE PERCENT ABSOLUTE ERROR | 33.89 |

UNIT HYDROGRAPH
95 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 70. | 262. | 539. | 868. | 1233. | 1591. | 1888. | 2107. | 2236. | 2234. |
| 2124. | 2007. | 1891. | 1782. | 1680. | 1583. | 1492. | 1406. | 1325. | 1249. |
| 1177. | 1109. | 1045. | 985. | 928. | 875. | 825. | 777. | 732. | 690. |
| 650. | 613. | 578. | 544. | 513. | 484. | 456. | 429. | 405. | 381. |
| 359. | 337. | 319. | 301. | 284. | 267. | 252. | 237. | 224. | 211. |
| 199. | 187. | 176. | 166. | 157. | 148. | 139. | 131. | 124. | 117. |
| 110. | 103. | 98. | 92. | 87. | 82. | 77. | 73. | 68. | 64. |
| 61. | 57. | 54. | 51. | 48. | 45. | 43. | 40. | 38. | 36. |
| 34. | 32. | 30. | 28. | 26. | 25. | 24. | 22. | 21. | 20. |
| 19. | 17. | 16. | 16. | 15. | | | | | |

HYDROGRAPH AT STATION ELMIRA

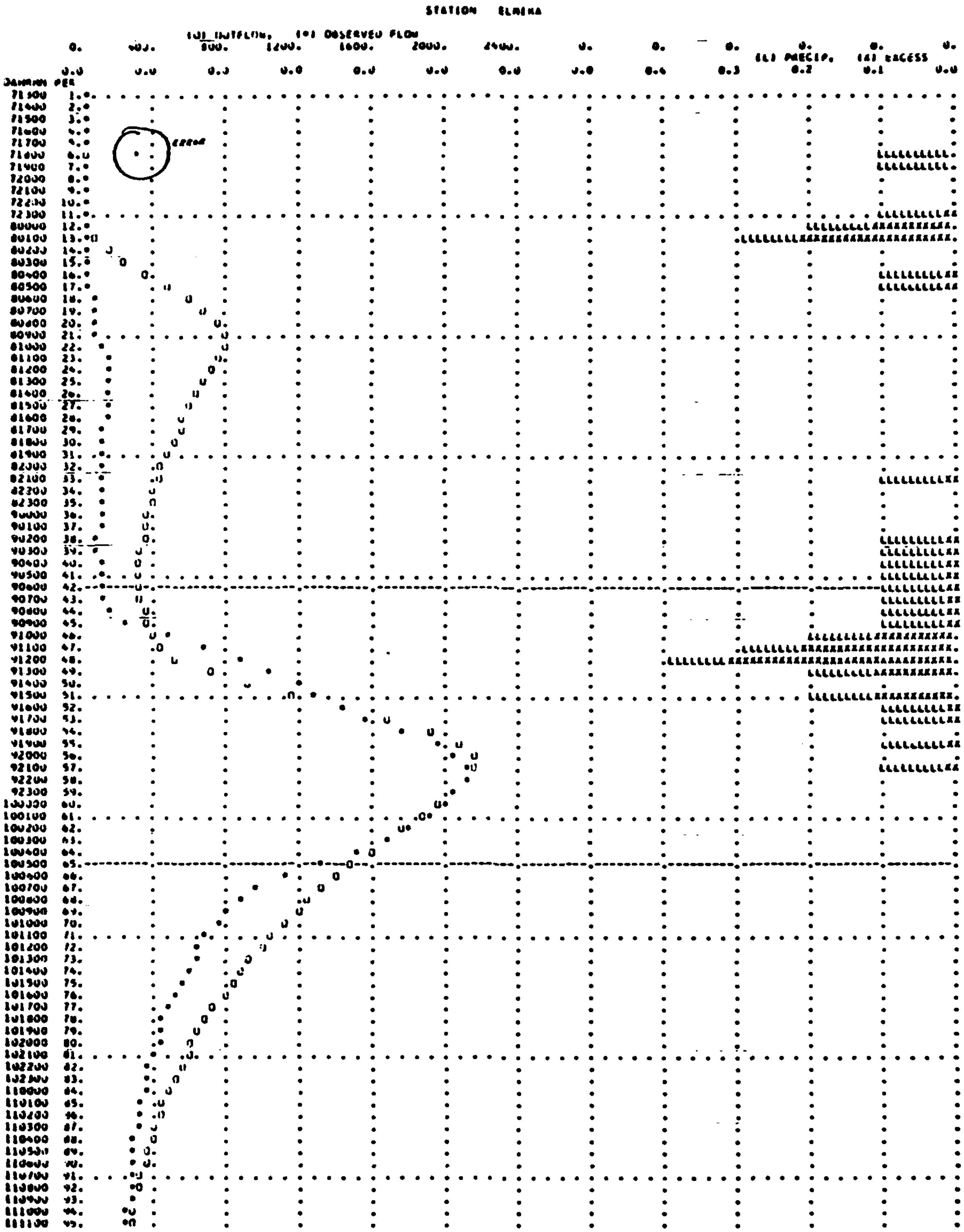
| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|
| 7 | OCT | 1300 | 1 | 0.00 | 0.00 | 0.00 | 32. | 32. |
| 7 | OCT | 1400 | 2 | 0.00 | 0.00 | 0.00 | 31. | 32. |
| 7 | OCT | 1500 | 3 | 0.00 | 0.00 | 0.00 | 30. | 32. |
| 7 | OCT | 1600 | 4 | 0.00 | 0.00 | 0.00 | 29. | 32. |
| 7 | OCT | 1700 | 5 | 0.00 | 0.00 | 0.00 | 28. | ~~32.~~ ERROR |
| 7 | OCT | 1800 | 6 | 0.10 | 0.10 | 0.00 | 27. | 320. 32. |
| 7 | OCT | 1900 | 7 | 0.10 | 0.10 | 0.00 | 26. | 32. |
| 7 | OCT | 2000 | 8 | 0.00 | 0.00 | 0.00 | 25. | 33. |
| 7 | OCT | 2100 | 9 | 0.00 | 0.00 | 0.00 | 24. | 34. |
| 7 | OCT | 2200 | 10 | 0.00 | 0.00 | 0.00 | 24. | 34. |
| 7 | OCT | 2300 | 11 | 0.10 | 0.09 | 0.01 | 23. | 35. |
| 8 | OCT | 0000 | 12 | 0.20 | 0.08 | 0.11 | 31. | 37. |
| 8 | OCT | 0100 | 13 | 0.29 | 0.08 | 0.21 | 64. | 44. |
| 8 | OCT | 0200 | 14 | 0.00 | 0.00 | 0.00 | 141. | 46. |
| 8 | OCT | 0300 | 15 | 0.00 | 0.00 | 0.00 | 237. | 46. |
| 8 | OCT | 0400 | 16 | 0.10 | 0.08 | 0.01 | 349. | 53. |
| 8 | OCT | 0500 | 17 | 0.10 | 0.09 | 0.01 | 470. | 55. |
| 8 | OCT | 0600 | 18 | 0.00 | 0.00 | 0.00 | 586. | 60. |
| 8 | OCT | 0700 | 19 | 0.00 | 0.00 | 0.00 | 681. | 64. |
| 8 | OCT | 0800 | 20 | 0.00 | 0.00 | 0.00 | 750. | 64. |
| 8 | OCT | 0900 | 21 | 0.00 | 0.00 | 0.00 | 786. | 76. |
| 8 | OCT | 1000 | 22 | 0.00 | 0.00 | 0.00 | 782. | 110. |
| 8 | OCT | 1100 | 23 | 0.00 | 0.00 | 0.00 | 752. | 156. |
| 8 | OCT | 1200 | 24 | 0.00 | 0.00 | 0.00 | 717. | 168. |
| 8 | OCT | 1300 | 25 | 0.00 | 0.00 | 0.00 | 682. | 167. |
| 8 | OCT | 1400 | 26 | 0.00 | 0.00 | 0.00 | 645. | 159. |
| 8 | OCT | 1500 | 27 | 0.00 | 0.00 | 0.00 | 608. | 152. |
| 8 | OCT | 1600 | 28 | 0.00 | 0.00 | 0.00 | 574. | 142. |
| 8 | OCT | 1700 | 29 | 0.00 | 0.00 | 0.00 | 541. | 136. |
| 8 | OCT | 1800 | 30 | 0.00 | 0.00 | 0.00 | 510. | 130. |
| 8 | OCT | 1900 | 31 | 0.00 | 0.00 | 0.00 | 481. | 123. |
| 8 | OCT | 2000 | 32 | 0.00 | 0.00 | 0.00 | 454. | 118. |
| 8 | OCT | 2100 | 33 | 0.10 | 0.08 | 0.01 | 429. | 116. |
| 8 | OCT | 2200 | 34 | 0.00 | 0.00 | 0.00 | 407. | 110. |
| 8 | OCT | 2300 | 35 | 0.00 | 0.00 | 0.00 | 388. | 108. |
| 9 | OCT | 0000 | 36 | 0.00 | 0.00 | 0.00 | 371. | 103. |
| 9 | OCT | 0100 | 37 | 0.00 | 0.00 | 0.00 | 356. | 100. |
| 9 | OCT | 0200 | 38 | 0.10 | 0.08 | 0.01 | 342. | 99. |
| 9 | OCT | 0300 | 39 | 0.10 | 0.08 | 0.01 | 332. | 99. |
| 9 | OCT | 0400 | 40 | 0.10 | 0.08 | 0.01 | 326. | 100. |
| 9 | OCT | 0500 | 41 | 0.10 | 0.08 | 0.01 | 324. | 104. |
| 9 | OCT | 0600 | 42 | 0.10 | 0.08 | 0.01 | 326. | 115. |
| 9 | OCT | 0700 | 43 | 0.10 | 0.09 | 0.01 | 332. | 138. |
| 9 | OCT | 0800 | 44 | 0.10 | 0.08 | 0.01 | 344. | 174. |
| 9 | OCT | 0900 | 45 | 0.10 | 0.08 | 0.01 | 359. | 220. |
| 9 | OCT | 1000 | 46 | 0.20 | 0.08 | 0.11 | 383. | 403. |
| 9 | OCT | 1100 | 47 | 0.29 | 0.08 | 0.21 | 434. | 670. |
| 9 | OCT | 1200 | 48 | 0.39 | 0.08 | 0.31 | 537. | 965. |

| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|
| 9 | OCT | 1300 | 49 | 0.20 | 0.08 | 0.11 | 703. | 1055. |
| 9 | OCT | 1400 | 50 | 0.00 | 0.00 | 0.00 | 918. | 1205. |
| 9 | OCT | 1500 | 51 | 0.20 | 0.08 | 0.11 | 1166. | 1284. |
| 9 | OCT | 1600 | 52 | 0.10 | 0.08 | 0.01 | 1433. | 1435. |
| 9 | OCT | 1700 | 53 | 0.10 | 0.08 | 0.01 | 1688. | 1555. |
| 9 | OCT | 1800 | 54 | 0.00 | 0.00 | 0.00 | 1904. | 1765. |
| 9 | OCT | 1900 | 55 | 0.10 | 0.08 | 0.01 | 2061. | 1940. |
| 9 | OCT | 2000 | 56 | 0.00 | 0.00 | 0.00 | 2147. | 2042. |
| 9 | OCT | 2100 | 57 | 0.10 | 0.08 | 0.01 | 2155. | 2105. |
| 9 | OCT | 2200 | 58 | 0.00 | 0.00 | 0.00 | 2109. | 2100. |
| 9 | OCT | 2300 | 59 | 0.00 | 0.00 | 0.00 | 2038. | 2055. |
| 10 | OCT | 0000 | 60 | 0.00 | 0.00 | 0.00 | 1954. | 1985. |
| 10 | OCT | 0100 | 61 | 0.00 | 0.00 | 0.00 | 1861. | 1900. |
| 10 | OCT | 0200 | 62 | 0.00 | 0.00 | 0.00 | 1767. | 1803. |
| 10 | OCT | 0300 | 63 | 0.00 | 0.00 | 0.00 | 1675. | 1678. |
| 10 | OCT | 0400 | 64 | 0.00 | 0.00 | 0.00 | 1585. | 1505. |
| 10 | OCT | 0500 | 65 | 0.00 | 0.00 | 0.00 | 1497. | 1313. |
| 10 | OCT | 0600 | 66 | 0.00 | 0.00 | 0.00 | 1413. | 1120. |
| 10 | OCT | 0700 | 67 | 0.00 | 0.00 | 0.00 | 1332. | 965. |
| 10 | OCT | 0800 | 68 | 0.00 | 0.00 | 0.00 | 1255. | 865. |
| 10 | OCT | 0900 | 69 | 0.00 | 0.00 | 0.00 | 1183. | 792. |
| 10 | OCT | 1000 | 70 | 0.00 | 0.00 | 0.00 | 1115. | 740. |
| 10 | OCT | 1100 | 71 | 0.00 | 0.00 | 0.00 | 1051. | 692. |
| 10 | OCT | 1200 | 72 | 0.00 | 0.00 | 0.00 | 991. | 652. |
| 10 | OCT | 1300 | 73 | 0.00 | 0.00 | 0.00 | 934. | 620. |
| 10 | OCT | 1400 | 74 | 0.00 | 0.00 | 0.00 | 880. | 593. |
| 10 | OCT | 1500 | 75 | 0.00 | 0.00 | 0.00 | 829. | 555. |
| 10 | OCT | 1600 | 76 | 0.00 | 0.00 | 0.00 | 782. | 530. |
| 10 | OCT | 1700 | 77 | 0.00 | 0.00 | 0.00 | 737. | 494. |
| 10 | OCT | 1800 | 78 | 0.00 | 0.00 | 0.00 | 694. | 455. |
| 10 | OCT | 1900 | 79 | 0.00 | 0.00 | 0.00 | 654. | 448. |
| 10 | OCT | 2000 | 80 | 0.00 | 0.00 | 0.00 | 617. | 433. |
| 10 | OCT | 2100 | 81 | 0.00 | 0.00 | 0.00 | 581. | 402. |
| 10 | OCT | 2200 | 82 | 0.00 | 0.00 | 0.00 | 548. | 376. |
| 10 | OCT | 2300 | 83 | 0.00 | 0.00 | 0.00 | 516. | 358. |
| 11 | OCT | 0000 | 84 | 0.00 | 0.00 | 0.00 | 487. | 342. |
| 11 | OCT | 0100 | 85 | 0.00 | 0.00 | 0.00 | 459. | 330. |
| 11 | OCT | 0200 | 86 | 0.00 | 0.00 | 0.00 | 432. | 318. |
| 11 | OCT | 0300 | 87 | 0.00 | 0.00 | 0.00 | 408. | 306. |
| 11 | OCT | 0400 | 88 | 0.00 | 0.00 | 0.00 | 384. | 298. |
| 11 | OCT | 0500 | 89 | 0.00 | 0.00 | 0.00 | 362. | 290. |
| 11 | OCT | 0600 | 90 | 0.00 | 0.00 | 0.00 | 341. | 282. |
| 11 | OCT | 0700 | 91 | 0.00 | 0.00 | 0.00 | 322. | 272. |
| 11 | OCT | 0800 | 92 | 0.00 | 0.00 | 0.00 | 310. | 268. |
| 11 | OCT | 0900 | 93 | 0.00 | 0.00 | 0.00 | 300. | 260. |
| 11 | OCT | 1000 | 94 | 0.00 | 0.00 | 0.00 | 290. | 252. |
| 11 | OCT | 1100 | 95 | 0.00 | 0.00 | 0.00 | 280. | 248. |

TOTAL RAINFALL = 3.51, TOTAL LOSS = 2.12, TOTAL EXCESS = 1.39

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 94.00-HR |
|---|---|---|---|---|---|---|
| 2155. | 56.00 | (CFS) | 2073. | 1551. | 874. | 703. |
| | | (INCHES) | 0.249 | 0.744 | 1.258 | 1.322 |
| | | (AC-FT) | 1028. | 3075. | 5201. | 5461. |

CUMULATIVE AREA = 77.50 SQ MI




(-) LIMITS OF OPTIMIZATION

```
                                        HEC-1 INPUT                                          PAGE  1

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1         ID        NEWTOWN CREEK 10-21-76
   2         ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
   3         IT      60 20OCT76    1300      46
   4         IO       1       2
   5         OU       5      25
   6         PG      EL    1.57
   7         PG      SP    1.46
   8         PG      AF
   9         PI     .10     .10     .10     .10     .10     .10     .10     .10     .20     .10
  10         PI     .10     .20     .00     .10     .10     .10     .00     .00     .00     .00
  11         PG     HOR
  12         PI     .00     .00     .20     .10     .10     .00     .10     .10     .20     .10
  13         PI     .20     .10     .00     .10     .00     .00     .00     .00     .00     .00

  14         KK  ELMIRA
  15         QO      53      53      54      56      59      63      69      80     110     168
  16         QO     328     670    1024    1190    1285    1407    1492    1590    1672    1700
  17         QO    1685    1593    1473    1270    1067     893     782     705     648     600
  18         QO     568     537     512     489     465     441     420     402     383     370
  19         QO     358     358     356     338     320     322       0       0       0       0
  20         PT      EL      SP      AF     HOR
  21         PW     .46     .06     .47     .01
  22         PR      AF     HOR
  23         PW     .85     .15
  24         BA    77.5      0.
  25         BF     53.    600.  1.0346
  26         UC    -1.0    -1.0
  27         LU     -1.     -1.
  28         ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 5 THROUGH 25)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.476 | | 11.05 | | | |
| COMPUTED HYDROGRAPH | 19978. | 0.399 | 951. | 18.48 | 7.43 | 1807. | 18.00 |
| OBSERVED HYDROGRAPH | 19995. | 0.400 | 952. | 18.46 | 7.41 | 1700. | 19.00 |
| DIFFERENCE | -17. | -0.000 | -1. | 0.02 | 0.02 | 107. | -1.00 |
| PERCENT DIFFERENCE | -0.08 | | | | 0.29 | 6.32 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 102. | AVERAGE ABSOLUTE ERROR | 78. |
| OBJECTIVE FUNCTION | 108. | AVERAGE PERCENT ABSOLUTE ERROR | 14.26 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 46)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.476 | | 11.05 | | | |
| COMPUTED HYDROGRAPH | 30269. | 0.605 | 658. | 23.71 | 12.67 | 1807. | 18.00 |
| OBSERVED HYDROGRAPH | 30478. | 0.609 | 663. | 23.64 | 12.60 | 1700. | 19.00 |
| DIFFERENCE | -209. | -0.004 | -5. | 0.07 | 0.07 | 107. | -1.00 |
| PERCENT DIFFERENCE | -0.69 | | | | 0.54 | 6.32 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 73. | AVERAGE ABSOLUTE ERROR | 48. |
| OBJECTIVE FUNCTION | 91. | AVERAGE PERCENT ABSOLUTE ERROR | 9.62 |

UNIT HYDROGRAPH
32 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 181. | 663. | 1297. | 1942. | 2703. | 3397. | 3961. | 4306. | 4436. | 4370. |
| 4068. | 3491. | 2837. | 2306. | 1874. | 1523. | 1236. | 1006. | 818. | 664. |
| 540. | 439. | 357. | 290. | 236. | 191. | 156. | 126. | 103. | 84. |
| 68. | 55. | | | | | | | | |

HYDROGRAPH AT STATION ELMIRA

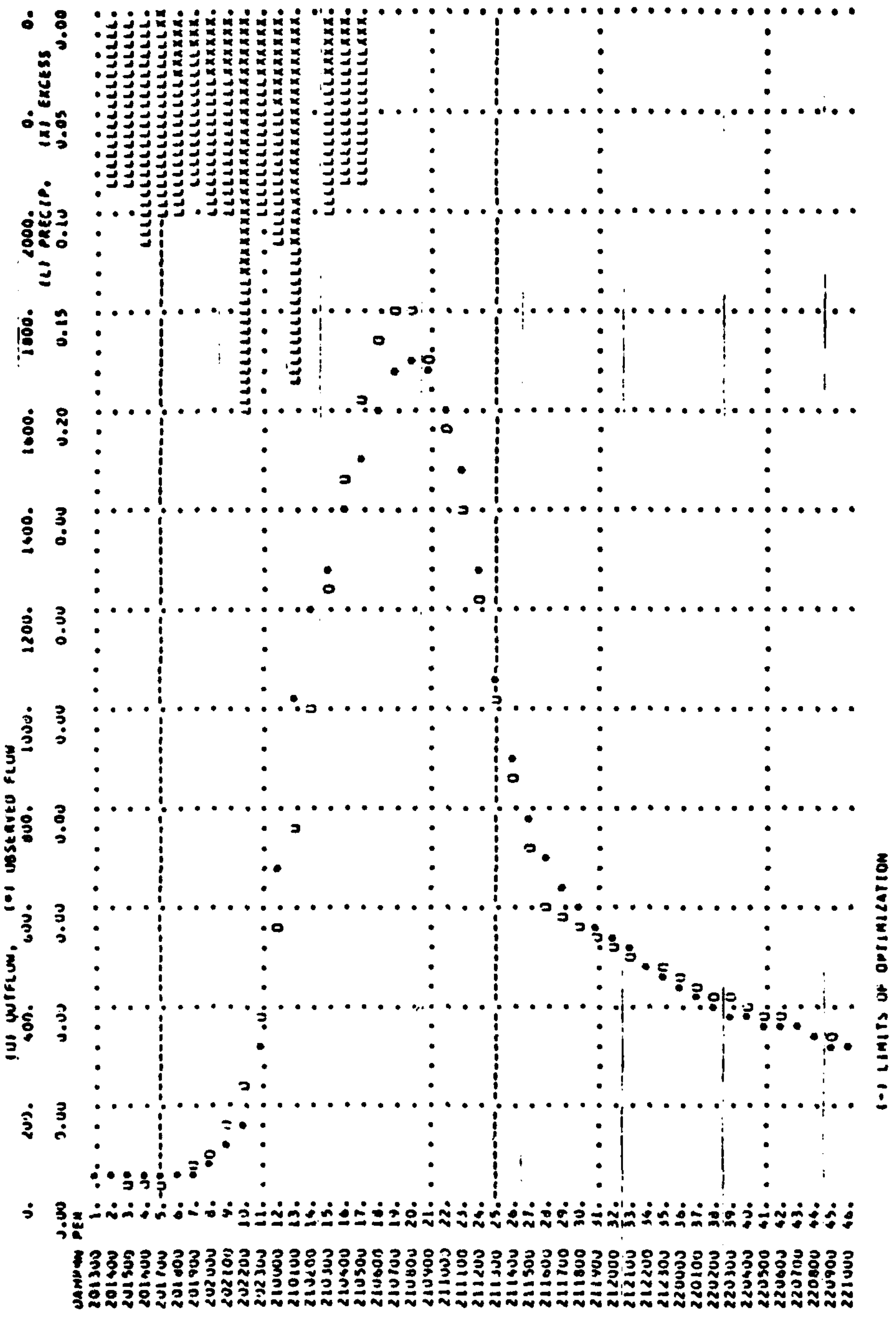
| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 20 OCT 1300 | 1 | 0.00 | 0.00 | 0.00 | 53. | 53. |
| 20 OCT 1400 | 2 | 0.08 | 0.08 | 0.00 | 51. | 53. |
| 20 OCT 1500 | 3 | 0.08 | 0.08 | 0.00 | 50. | 54. |
| 20 OCT 1600 | 4 | 0.11 | 0.11 | 0.00 | 48. | 56. |
| 20 OCT 1700 | 5 | 0.10 | 0.09 | 0.01 | 48. | 59. |
| 20 OCT 1800 | 6 | 0.10 | 0.07 | 0.03 | 55. | 63. |
| 20 OCT 1900 | 7 | 0.08 | 0.07 | 0.01 | 74. | 69. |
| 20 OCT 2000 | 8 | 0.10 | 0.07 | 0.03 | 108. | 80. |
| 20 OCT 2100 | 9 | 0.10 | 0.07 | 0.03 | 160. | 110. |
| 20 OCT 2200 | 10 | 0.20 | 0.07 | 0.13 | 249. | 168. |
| 20 OCT 2300 | 11 | 0.10 | 0.07 | 0.03 | 386. | 328. |
| 21 OCT 0000 | 12 | 0.11 | 0.07 | 0.04 | 556. | 670. |
| 21 OCT 0100 | 13 | 0.18 | 0.07 | 0.11 | 762. | 1024. |
| 21 OCT 0200 | 14 | 0.00 | 0.00 | 0.00 | 998. | 1190. |
| 21 OCT 0300 | 15 | 0.10 | 0.07 | 0.03 | 1236. | 1285. |
| 21 OCT 0400 | 16 | 0.08 | 0.07 | 0.01 | 1453. | 1407. |
| 21 OCT 0500 | 17 | 0.08 | 0.07 | 0.01 | 1626. | 1492. |
| 21 OCT 0600 | 18 | 0.00 | 0.00 | 0.00 | 1749. | 1590. |
| 21 OCT 0700 | 19 | 0.00 | 0.00 | 0.00 | 1807. | 1672. |
| 21 OCT 0800 | 20 | 0.00 | 0.00 | 0.00 | 1792. | 1700. |
| 21 OCT 0900 | 21 | 0.00 | 0.00 | 0.00 | 1705. | 1685. |
| 21 OCT 1000 | 22 | 0.00 | 0.00 | 0.00 | 1568. | 1593. |
| 21 OCT 1100 | 23 | 0.00 | 0.00 | 0.00 | 1403. | 1473. |

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 21 OCT 1200 | 24 | 0.00 | 0.00 | 0.00 | 1215. | 1270. |
| 21 OCT 1300 | 25 | 0.00 | 0.00 | 0.00 | 1030. | 1067. |
| 21 OCT 1400 | 26 | 0.00 | 0.00 | 0.00 | 863. | 893. |
| 21 OCT 1500 | 27 | 0.00 | 0.00 | 0.00 | 715. | 782. |
| 21 OCT 1600 | 28 | 0.00 | 0.00 | 0.00 | 598. | 705. |
| 21 OCT 1700 | 29 | 0.00 | 0.00 | 0.00 | 578. | 648. |
| 21 OCT 1800 | 30 | 0.00 | 0.00 | 0.00 | 559. | 600. |
| 21 OCT 1900 | 31 | 0.00 | 0.00 | 0.00 | 540. | 568. |
| 21 OCT 2000 | 32 | 0.00 | 0.00 | 0.00 | 522. | 537. |
| 21 OCT 2100 | 33 | 0.00 | 0.00 | 0.00 | 504. | 512. |
| 21 OCT 2200 | 34 | 0.00 | 0.00 | 0.00 | 488. | 489. |
| 21 OCT 2300 | 35 | 0.00 | 0.00 | 0.00 | 471. | 465. |
| 22 OCT 0000 | 36 | 0.00 | 0.00 | 0.00 | 455. | 441. |
| 22 OCT 0100 | 37 | 0.00 | 0.00 | 0.00 | 440. | 420. |
| 22 OCT 0200 | 38 | 0.00 | 0.00 | 0.00 | 426. | 402. |
| 22 OCT 0300 | 39 | 0.00 | 0.00 | 0.00 | 411. | 383. |
| 22 OCT 0400 | 40 | 0.00 | 0.00 | 0.00 | 398. | 370. |
| 22 OCT 0500 | 41 | 0.00 | 0.00 | 0.00 | 384. | 358. |
| 22 OCT 0600 | 42 | 0.00 | 0.00 | 0.00 | 371. | 358. |
| 22 OCT 0700 | 43 | 0.00 | 0.00 | 0.00 | 359. | 356. |
| 22 OCT 0800 | 44 | 0.00 | 0.00 | 0.00 | 347. | 338. |
| 22 OCT 0900 | 45 | 0.00 | 0.00 | 0.00 | 335. | 320. |
| 22 OCT 1000 | 46 | 0.00 | 0.00 | 0.00 | 324. | 322. |

TOTAL RAINFALL = 1.62, TOTAL LOSS = 1.15, TOTAL EXCESS = 0.48

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 45.00-HR |
|---|---|---|---|---|---|---|
| 1807. | 18.00 | (CFS) | 1698. | 1329. | 668. | 668. |
| | | (INCHES) | 0.204 | 0.494 | 0.601 | 0.601 |
| | | (AC-FT) | 842. | 2341. | 2486. | 2486. |

CUMULATIVE AREA = 77.50 SQ MI



STATION ELMIRA
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP.
(X) EXCESS
(-) LIMITS OF OPTIMIZATION

HEC-1 INPUT 

```
LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1         ID        NEWTOWN CREEK 09-25-77
  2         ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3         IT      60 24SEP77    1300      46
  4         IO       1       2
  5         OU       5      30
  6         PG      EL    2.21
  7         PG      SP    2.60
  8         PG      AF
  9         PI     .00     .10     .20     .20     .10     .20     .20     .30     .10     .20
 10         PI     .20     .10     .10     .10     .10     .00     .00     .00     .00     .00
 11         PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 12         PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 13         PI     .00     .00     .10     .10     .10     .00     .00     .00     .00     .00
 14         PG     HOR
 15         PI     .00     .10     .20     .10     .30     .20     .00     .20     .10     .10
 16         PI     .10     .10     .20     .00     .00     .00     .00     .00     .00     .00
 17         PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 18         PI     .00     .00     .00     .00     .00     .00     .00     .00     .10     .00
 19         PI     .00     .00     .00     .20     .10     .00     .00     .00     .00     .00

 20         KK  ELMIRA
 21         QO      62      62      62      62      66      66      80      92     112     163
 22         QO     320     670    1015    1175    1250    1400    1435    1494    1555    1633
 23         QO    1685    1708    1670    1575    1443    1280    1103     962     860     782
 24         QO     724     676     635     598     555     512     472     449     428     410
 25         QO     395     381     370     360     358     360       0       0       0       0
 26         PT      EL      SP      AF     HOR
 27         PW     .46     .06     .47     .01
 28         PR      AF     HOR
 29         PW     .85     .15
 30         BA    77.5      0.
 31         BF     62.    860.  1.0346
 32         OC    -11.    -13.
 33         LO     -1.     -1.
 34         ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 5 THROUGH 30)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.810 | | 13.64 | | | |
| COMPUTED HYDROGRAPH | 25511. | 0.510 | 981. | 20.65 | 7.00 | 1715. | 18.00 |
| OBSERVED HYDROGRAPH | 25594. | 0.512 | 984. | 20.48 | 6.84 | 1708. | 21.00 |
| DIFFERENCE | -83. | -0.002 | -3. | 0.17 | 0.17 | 7. | -3.00 |
| PERCENT DIFFERENCE | -0.32 | | | | 2.44 | 0.41 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 112. | AVERAGE ABSOLUTE ERROR | 91. |
| OBJECTIVE FUNCTION | 119. | AVERAGE PERCENT ABSOLUTE ERROR | 13.52 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 46)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.810 | | 13.64 | | | |
| COMPUTED HYDROGRAPH | 36552. | 0.731 | 795. | 25.59 | 11.95 | 1715. | 18.00 |
| OBSERVED HYDROGRAPH | 33525. | 0.670 | 729. | 24.23 | 10.58 | 1708. | 21.00 |
| DIFFERENCE | 3027. | 0.061 | 66. | 1.37 | 1.37 | 7. | -3.00 |
| PERCENT DIFFERENCE | 9.03 | | | | 12.91 | 0.41 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 144. | AVERAGE ABSOLUTE ERROR | 120. |
| OBJECTIVE FUNCTION | 148. | AVERAGE PERCENT ABSOLUTE ERROR | 24.93 |

UNIT HYDROGRAPH
78 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 75. | 280. | 571. | 918. | 1300. | 1692. | 2040. | 2308. | 2490. | 2574. |
| 2518. | 2359. | 2192. | 2036. | 1892. | 1758. | 1633. | 1517. | 1409. | 1309. |
| 1214. | 1130. | 1050. | 975. | 906. | 842. | 782. | 727. | 675. | 627. |
| 583. | 541. | 503. | 467. | 434. | 403. | 375. | 348. | 323. | 300. |
| 279. | 259. | 241. | 224. | 208. | 193. | 179. | 167. | 155. | 144. |
| 134. | 124. | 115. | 107. | 100. | 93. | 86. | 80. | 74. | 69. |
| 64. | 59. | 55. | 51. | 48. | 44. | 41. | 38. | 36. | 33. |
| 31. | 28. | 26. | 25. | 23. | 21. | 20. | 18. | | |

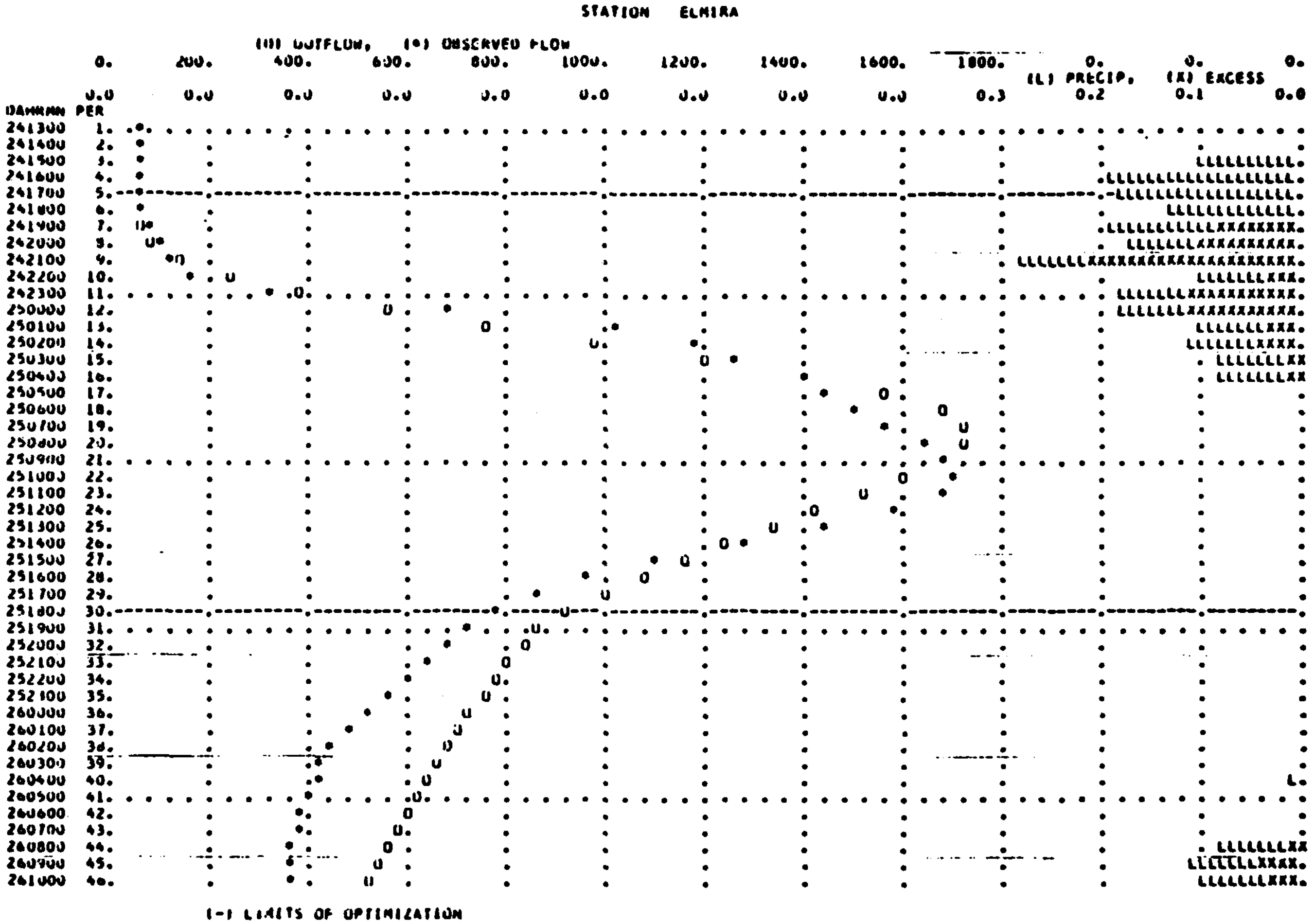
HYDROGRAPH AT STATION ELMIRA

| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|
| 24 | SEP | 1300 | 1 | 0.00 | 0.00 | 0.00 | 62. | 62. |
| 24 | SEP | 1400 | 2 | 0.00 | 0.00 | 0.00 | 60. | 62. |
| 24 | SEP | 1500 | 3 | 0.10 | 0.10 | 0.00 | 58. | 62. |
| 24 | SEP | 1600 | 4 | 0.19 | 0.19 | 0.00 | 56. | 62. |
| 24 | SEP | 1700 | 5 | 0.18 | 0.18 | 0.00 | 54. | 66. |
| 24 | SEP | 1800 | 6 | 0.13 | 0.13 | 0.00 | 52. | 66. |
| 24 | SEP | 1900 | 7 | 0.19 | 0.11 | 0.08 | 57. | 80. |
| 24 | SEP | 2000 | 8 | 0.17 | 0.07 | 0.10 | 83. | 92. |
| 24 | SEP | 2100 | 9 | 0.28 | 0.07 | 0.21 | 138. | 112. |
| 24 | SEP | 2200 | 10 | 0.10 | 0.07 | 0.03 | 237. | 163. |
| 24 | SEP | 2300 | 11 | 0.18 | 0.07 | 0.11 | 375. | 320. |
| 25 | SEP | 0000 | 12 | 0.18 | 0.07 | 0.11 | 553. | 670. |
| 25 | SEP | 0100 | 13 | 0.10 | 0.07 | 0.03 | 763. | 1015. |
| 25 | SEP | 0200 | 14 | 0.11 | 0.07 | 0.04 | 988. | 1175. |
| 25 | SEP | 0300 | 15 | 0.08 | 0.07 | 0.01 | 1208. | 1250. |
| 25 | SEP | 0400 | 16 | 0.08 | 0.07 | 0.01 | 1406. | 1400. |
| 25 | SEP | 0500 | 17 | 0.00 | 0.00 | 0.00 | 1565. | 1435. |
| 25 | SEP | 0600 | 18 | 0.00 | 0.00 | 0.00 | 1670. | 1494. |
| 25 | SEP | 0700 | 19 | 0.00 | 0.00 | 0.00 | 1715. | 1555. |
| 25 | SEP | 0800 | 20 | 0.00 | 0.00 | 0.00 | 1712. | 1633. |
| 25 | SEP | 0900 | 21 | 0.00 | 0.00 | 0.00 | 1673. | 1685. |
| 25 | SEP | 1000 | 22 | 0.00 | 0.00 | 0.00 | 1605. | 1708. |
| 25 | SEP | 1100 | 23 | 0.00 | 0.00 | 0.00 | 1518. | 1670. |
| 25 | SEP | 1200 | 24 | 0.00 | 0.00 | 0.00 | 1425. | 1575. |
| 25 | SEP | 1300 | 25 | 0.00 | 0.00 | 0.00 | 1331. | 1443. |
| 25 | SEP | 1400 | 26 | 0.00 | 0.00 | 0.00 | 1239. | 1280. |
| 25 | SEP | 1500 | 27 | 0.00 | 0.00 | 0.00 | 1153. | 1103. |
| 25 | SEP | 1600 | 28 | 0.00 | 0.00 | 0.00 | 1072. | 962. |
| 25 | SEP | 1700 | 29 | 0.00 | 0.00 | 0.00 | 997. | 860. |
| 25 | SEP | 1800 | 30 | 0.00 | 0.00 | 0.00 | 927. | 782. |
| 25 | SEP | 1900 | 31 | 0.00 | 0.00 | 0.00 | 862. | 724. |
| 25 | SEP | 2000 | 32 | 0.00 | 0.00 | 0.00 | 832. | 676. |
| 25 | SEP | 2100 | 33 | 0.00 | 0.00 | 0.00 | 804. | 635. |
| 25 | SEP | 2200 | 34 | 0.00 | 0.00 | 0.00 | 777. | 598. |
| 25 | SEP | 2300 | 35 | 0.00 | 0.00 | 0.00 | 751. | 555. |
| 26 | SEP | 0000 | 36 | 0.00 | 0.00 | 0.00 | 726. | 512. |
| 26 | SEP | 0100 | 37 | 0.00 | 0.00 | 0.00 | 702. | 472. |
| 26 | SEP | 0200 | 38 | 0.00 | 0.00 | 0.00 | 679. | 449. |
| 26 | SEP | 0300 | 39 | 0.00 | 0.00 | 0.00 | 656. | 428. |
| 26 | SEP | 0400 | 40 | 0.01 | 0.01 | 0.00 | 634. | 410. |
| 26 | SEP | 0500 | 41 | 0.00 | 0.00 | 0.00 | 613. | 395. |
| 26 | SEP | 0600 | 42 | 0.00 | 0.00 | 0.00 | 592. | 381. |
| 26 | SEP | 0700 | 43 | 0.00 | 0.00 | 0.00 | 572. | 370. |
| 26 | SEP | 0800 | 44 | 0.08 | 0.07 | 0.01 | 553. | 360. |
| 26 | SEP | 0900 | 45 | 0.11 | 0.07 | 0.04 | 535. | 358. |
| 26 | SEP | 1000 | 46 | 0.10 | 0.07 | 0.03 | 517. | 360. |

TOTAL RAINFALL = 2.37, TOTAL LOSS = 1.56, TOTAL EXCESS = 0.81

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 45.00-HR |
|---|---|---|---|---|---|---|
| 1715. | 18.00 | (CFS) | 1653. | 1195. | 806. | 806. |
| | | (INCHES) | 0.198 | 0.574 | 0.725 | 0.725 |
| | | (AC-FT) | 819. | 2371. | 2997. | 2997. |

CUMULATIVE AREA = 77.50 SQ MI


STATION ELMIRA
(O) OUTFLOW, (*) OBSERVED FLOW
0. 200. 400. 600. 800. 1000. 1200. 1400. 1600. 1800.
(L) PRECIP. (X) EXCESS
0. 0. 0.
0.3 0.2 0.1 0.0
DAHRMN PER
(-) LIMITS OF OPTIMIZATION

```
LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1            ID        NEWTOWN CREEK 10-17-77
  2            ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3            IT      60 16OCT77    0400      62
  4            IO       1       2
  5            OO       5      45
  6            PG      EL    2.18
  7            PG      SP    3.06
  8            PG      AF
  9            PI     .00     .00     .10     .00     .10     .10     .00     .10     .10     .00
 10            PI     .00     .10     .10     .10     .00     .10     .20     .10     .10     .20
 11            PI     .30     .20     .10     .10     .10     .00     .10     .10     .00     .10
 12            PI     .00     .10     .00     .10     .00     .00     .00     .00     .00     .00
 13            PG     HOR
 14            PI     .10     .00     .10     .10     .10     .10     .10     .00     .00     .00
 15            PI     .10     .00     .10     .00     .00     .00     .10     .00     .10     .00
 16            PI     .00     .00     .10     .10     .00     .10     .00     .00     .00     .00
 17            PI     .00     .00     .00     .00     .10     .30     .00     .00     .00     .00

 18            KK  ELMIRA
 19            QO      77      77      77      78      81      87      92      99     110     131
 20            QO     178     286     396     470     534     577     628     686     743     802
 21            QO     906    1074    1155    1221    1332    1431    1530    1650    1761    1821
 22            QO    1844    1830    1776    1728    1662    1578    1482    1383    1287    1200
 23            QO    1128    1077    1035     990     945     864     838     791     746     701
 24            QO     662     628     601     575     555     534     518     499     482     468
 25            QO     458     450       0       0       0       0       0       0       0       0
 26            PT      EL      SP      AF     HOR
 27            PW     .46     .06     .47     .01
 28            PR      AF     HOR
 29            PW     .85     .15
 30            BA    77.5      0.
 31            BF     77.    570.  1.0346
 32            UC     -9.    -15.
 33            LU    -.04    -.03
 34            ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 5 THROUGH 45)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.076 | | 19.65 | | | |
| COMPUTED HYDROGRAPH | 40462. | 0.809 | 987. | 30.47 | 10.82 | 1863. | 29.00 |
| OBSERVED HYDROGRAPH | 40726. | 0.814 | 993. | 30.21 | 10.56 | 1844. | 30.00 |
| DIFFERENCE | -264. | -0.005 | -6. | 0.26 | 0.26 | 19. | -1.00 |
| PERCENT DIFFERENCE | -0.65 | | | | 2.50 | 1.05 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 103. | AVERAGE ABSOLUTE ERROR | 86. |
| OBJECTIVE FUNCTION | 102. | AVERAGE PERCENT ABSOLUTE ERROR | 16.80 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 62)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.076 | | 19.65 | | | |
| COMPUTED HYDROGRAPH | 51167. | 1.023 | 825. | 34.86 | 15.21 | 1863. | 29.00 |
| OBSERVED HYDROGRAPH | 51405. | 1.028 | 829. | 34.63 | 14.98 | 1844. | 30.00 |
| DIFFERENCE | -238. | -0.005 | -4. | 0.23 | 0.23 | 19. | -1.00 |
| PERCENT DIFFERENCE | -0.46 | | | | 1.53 | 1.05 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 84. | AVERAGE ABSOLUTE ERROR | 61. |
| OBJECTIVE FUNCTION | 91. | AVERAGE PERCENT ABSOLUTE ERROR | 12.52 |

UNIT HYDROGRAPH
90 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 49. | 337. | 691. | 1112. | 1556. | 1946. | 2233. | 2396. | 2385. | 2256. |
| 2119. | 1991. | 1871. | 1757. | 1651. | 1551. | 1457. | 1369. | 1286. | 1208. |
| 1135. | 1066. | 1002. | 941. | 884. | 831. | 780. | 733. | 689. | 647. |
| 608. | 571. | 537. | 504. | 474. | 445. | 418. | 393. | 369. | 347. |
| 326. | 306. | 287. | 270. | 254. | 238. | 224. | 210. | 198. | 186. |
| 174. | 164. | 154. | 145. | 136. | 128. | 120. | 113. | 106. | 99. |
| 93. | 88. | 82. | 77. | 73. | 68. | 64. | 60. | 57. | 53. |
| 50. | 47. | 44. | 41. | 39. | 37. | 34. | 32. | 30. | 29. |
| 27. | 25. | 24. | 22. | 21. | 20. | 18. | 17. | 16. | 15. |

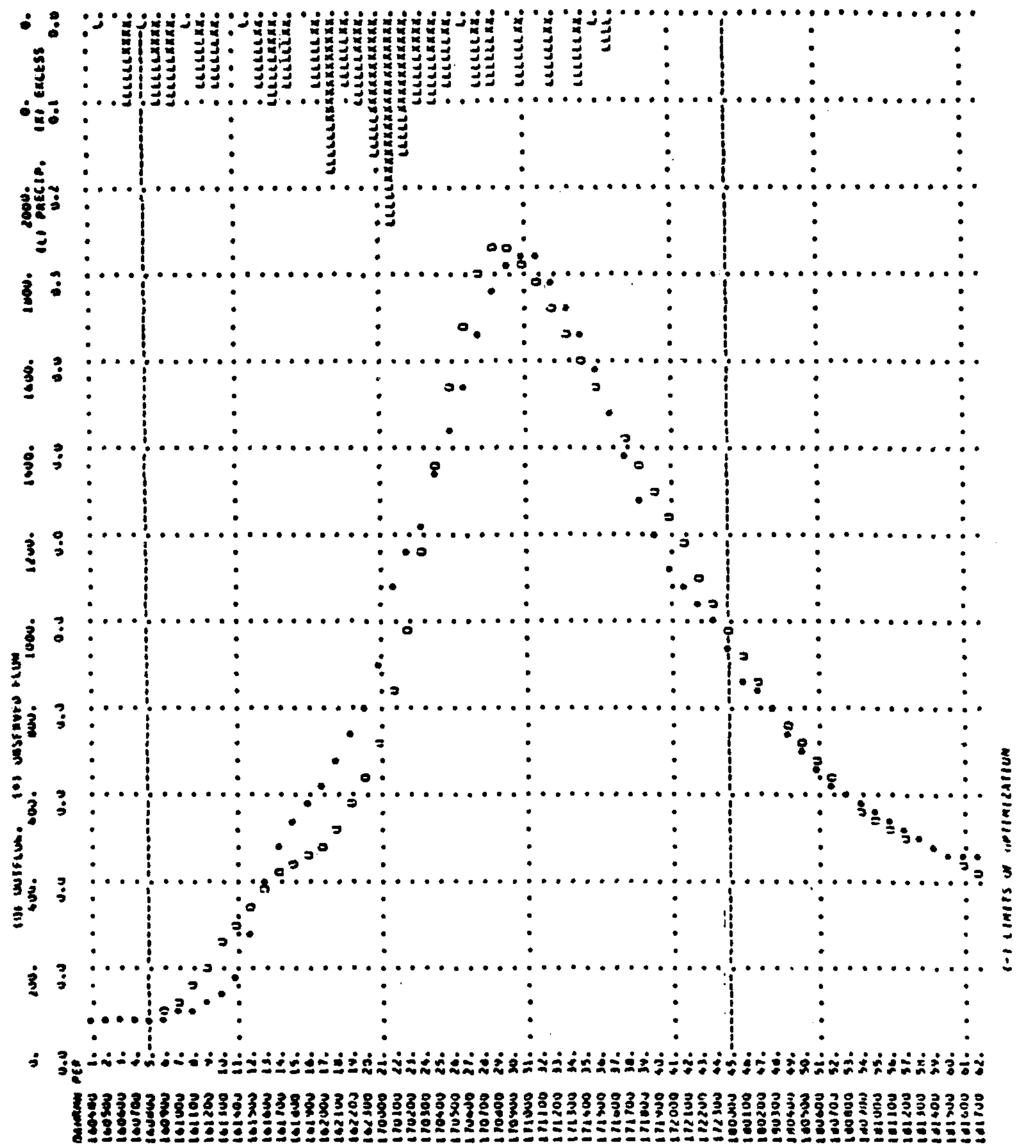
HYDROGRAPH AT STATION ELMIRA

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 OCT 0400 | 1 | 0.00 | 0.00 | 0.00 | 77. | 77. | 17 OCT 1100 | 32 | 0.00 | 0.00 | 0.00 | 1777. | 1830. |
| 16 OCT 0500 | 2 | 0.01 | 0.01 | 0.00 | 74. | 77. | 17 OCT 1200 | 33 | 0.08 | 0.06 | 0.02 | 1718. | 1776. |
| 16 OCT 0600 | 3 | 0.00 | 0.00 | 0.00 | 72. | 77. | 17 OCT 1300 | 34 | 0.00 | 0.00 | 0.00 | 1658. | 1728. |
| 16 OCT 0700 | 4 | 0.10 | 0.06 | 0.04 | 73. | 78. | 17 OCT 1400 | 35 | 0.08 | 0.06 | 0.02 | 1599. | 1662. |
| 16 OCT 0800 | 5 | 0.01 | 0.01 | 0.00 | 80. | 81. | 17 OCT 1500 | 36 | 0.01 | 0.01 | 0.00 | 1542. | 1578. |
| 16 OCT 0900 | 6 | 0.10 | 0.06 | 0.04 | 95. | 87. | 17 OCT 1600 | 37 | 0.04 | 0.04 | 0.00 | 1484. | 1482. |
| 16 OCT 1000 | 7 | 0.10 | 0.06 | 0.04 | 122. | 92. | 17 OCT 1700 | 38 | 0.00 | 0.00 | 0.00 | 1425. | 1383. |
| 16 OCT 1100 | 8 | 0.01 | 0.01 | 0.00 | 160. | 99. | 17 OCT 1800 | 39 | 0.00 | 0.00 | 0.00 | 1365. | 1287. |
| 16 OCT 1200 | 9 | 0.08 | 0.06 | 0.02 | 205. | 110. | 17 OCT 1900 | 40 | 0.00 | 0.00 | 0.00 | 1302. | 1200. |
| 16 OCT 1300 | 10 | 0.08 | 0.06 | 0.02 | 255. | 131. | 17 OCT 2000 | 41 | 0.00 | 0.00 | 0.00 | 1237. | 1128. |
| 16 OCT 1400 | 11 | 0.00 | 0.00 | 0.00 | 306. | 178. | 17 OCT 2100 | 42 | 0.00 | 0.00 | 0.00 | 1170. | 1077. |
| 16 OCT 1500 | 12 | 0.01 | 0.01 | 0.00 | 349. | 286. | 17 OCT 2200 | 43 | 0.00 | 0.00 | 0.00 | 1103. | 1035. |
| 16 OCT 1600 | 13 | 0.08 | 0.06 | 0.02 | 382. | 396. | 17 OCT 2300 | 44 | 0.00 | 0.00 | 0.00 | 1037. | 990. |
| 16 OCT 1700 | 14 | 0.10 | 0.06 | 0.04 | 411. | 470. | 18 OCT 0000 | 45 | 0.00 | 0.00 | 0.00 | 975. | 945. |
| 16 OCT 1800 | 15 | 0.08 | 0.06 | 0.02 | 435. | 534. | 18 OCT 0100 | 46 | 0.00 | 0.00 | 0.00 | 916. | 864. |
| 16 OCT 1900 | 16 | 0.00 | 0.00 | 0.00 | 459. | 577. | 18 OCT 0200 | 47 | 0.00 | 0.00 | 0.00 | 861. | 838. |
| 16 OCT 2000 | 17 | 0.08 | 0.06 | 0.02 | 485. | 628. | 18 OCT 0300 | 48 | 0.00 | 0.00 | 0.00 | 810. | 791. |
| 16 OCT 2100 | 18 | 0.18 | 0.06 | 0.12 | 519. | 686. | 18 OCT 0400 | 49 | 0.00 | 0.00 | 0.00 | 761. | 746. |
| 16 OCT 2200 | 19 | 0.08 | 0.06 | 0.02 | 572. | 743. | 18 OCT 0500 | 50 | 0.00 | 0.00 | 0.00 | 715. | 701. |
| 16 OCT 2300 | 20 | 0.10 | 0.06 | 0.04 | 638. | 802. | 18 OCT 0600 | 51 | 0.00 | 0.00 | 0.00 | 672. | 662. |
| 17 OCT 0000 | 21 | 0.16 | 0.06 | 0.11 | 721. | 906. | 18 OCT 0700 | 52 | 0.00 | 0.00 | 0.00 | 632. | 628. |
| 17 OCT 0100 | 22 | 0.24 | 0.06 | 0.19 | 833. | 1074. | 18 OCT 0800 | 53 | 0.00 | 0.00 | 0.00 | 594. | 601. |
| 17 OCT 0200 | 23 | 0.16 | 0.06 | 0.11 | 982. | 1155. | 18 OCT 0900 | 54 | 0.00 | 0.00 | 0.00 | 564. | 575. |
| 17 OCT 0300 | 24 | 0.10 | 0.06 | 0.04 | 1159. | 1221. | 18 OCT 1000 | 55 | 0.00 | 0.00 | 0.00 | 545. | 555. |
| 17 OCT 0400 | 25 | 0.10 | 0.06 | 0.04 | 1350. | 1332. | 18 OCT 1100 | 56 | 0.00 | 0.00 | 0.00 | 527. | 534. |
| 17 OCT 0500 | 26 | 0.08 | 0.06 | 0.02 | 1530. | 1431. | 18 OCT 1200 | 57 | 0.00 | 0.00 | 0.00 | 509. | 518. |
| 17 OCT 0600 | 27 | 0.01 | 0.01 | 0.00 | 1680. | 1530. | 18 OCT 1300 | 58 | 0.00 | 0.00 | 0.00 | 492. | 499. |
| 17 OCT 0700 | 28 | 0.08 | 0.06 | 0.02 | 1792. | 1650. | 18 OCT 1400 | 59 | 0.00 | 0.00 | 0.00 | 476. | 482. |
| 17 OCT 0800 | 29 | 0.08 | 0.06 | 0.02 | 1855. | 1761. | 18 OCT 1500 | 60 | 0.00 | 0.00 | 0.00 | 460. | 468. |
| 17 OCT 0900 | 30 | 0.00 | 0.00 | 0.00 | 1863. | 1821. | 18 OCT 1600 | 61 | 0.00 | 0.00 | 0.00 | 444. | 458. |
| 17 OCT 1000 | 31 | 0.08 | 0.06 | 0.02 | 1829. | 1844. | 18 OCT 1700 | 62 | 0.00 | 0.00 | 0.00 | 430. | 450. |

TOTAL RAINFALL = 2.52, TOTAL LOSS = 1.44, TOTAL EXCESS = 1.08

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 61.00-HR |
|---|---|---|---|---|---|---|
| 1863. | 29.00 | (CFS) | 1803. | 1430. | 835. | 835. |
| | | (INCHES) | 0.216 | 0.686 | 1.018 | 1.018 |
| | | (AC-FT) | 894. | 2835. | 4208. | 4208. |

CUMULATIVE AREA = 77.50 SQ MI


STATION ELMIRA
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP.
(X) EXCESS
(-) LIMITS OF OPTIMIZATION

HEC-1 INPUT

PAGE 1

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LINE    ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1     ID        NEWTOWN CREEK 11-04-77
  2     ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3     IT      60 03NOV77    2300      68
  4     IO       1       2
  5     OU      10      35
  6     PG      EL    2.24
  7     PG      SP    2.28
  8     PG      AF
  9     PI     .00     .00     .00     .10     .10     .00     .00     .10     .30     .10
 10     PI     .00     .10     .00     .10     .00     .20     .20     .20     .00     .10
 11     PG     HOR
 12     PI     .00     .10     .10     .10     .10     .00     .00     .00     .00     .00
 13     PI     .00     .00     .10     .00     .10     .00     .00     .00     .00     .00

 14     KK  ELMIRA
 15     QO      54      54      54      55      57      58      63      66      68      89
 16     QO     101     138     204     212     307     329     465     571     350    1083
 17     QO    1248    1368    1497    1653    1785    1842    1800    1710    1596    1446
 18     QO    1296    1161    1053     969     900     844     796     754     718     679
 19     QO     637     599     571     542     525     506     486     475     465     451
 20     QO     439     428     420     409     400     391     381     373     367     356
 21     QO     340     329     323     316     310     303     299     292       0       0
 22     PT      EL      SP      AF     HOR
 23     PW     .46     .06     .47     .01
 24     PR      AF     HOR
 25     PW     .85     .15
 26     BA    77.5      0.
 27     BF     54.    500.  1.0346
 28     UC    -10.    -13.
 29     LU     -.4    -.05
 30     ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 10 THROUGH 35)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.714 | | 16.33 | | | |
| COMPUTED HYDROGRAPH | 25830. | 0.516 | 993. | 25.81 | 9.48 | 1829. | 25.00 |
| OBSERVED HYDROGRAPH | 25673. | 0.513 | 987. | 25.74 | 9.41 | 1842. | 25.00 |
| DIFFERENCE | 157. | 0.003 | 6. | 0.07 | 0.07 | -13. | 0.00 |
| PERCENT DIFFERENCE | 0.61 | | | | 0.78 | -0.70 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 54. | AVERAGE ABSOLUTE ERROR | 46. |
| OBJECTIVE FUNCTION | 54. | AVERAGE PERCENT ABSOLUTE ERROR | 9.19 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 68)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.714 | | 16.33 | | | |
| COMPUTED HYDROGRAPH | 39765. | 0.795 | 585. | 33.22 | 16.89 | 1829. | 25.00 |
| OBSERVED HYDROGRAPH | 41726. | 0.834 | 614. | 34.17 | 17.84 | 1842. | 25.00 |
| DIFFERENCE | -1961. | -0.039 | -29. | -0.95 | -0.95 | -13. | 0.00 |
| PERCENT DIFFERENCE | -4.70 | | | | -5.32 | -0.70 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 57. | AVERAGE ABSOLUTE ERROR | 48. |
| OBJECTIVE FUNCTION | 60. | AVERAGE PERCENT ABSOLUTE ERROR | 12.74 |

UNIT HYDROGRAPH
68 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 103. | 386. | 784. | 1251. | 1758. | 2231. | 2597. | 2834. | 2931. | 2826. |
| 2604. | 2396. | 2202. | 2025. | 1861. | 1711. | 1573. | 1446. | 1330. | 1223. |
| 1124. | 1033. | 950. | 873. | 803. | 738. | 679. | 624. | 574. | 527. |
| 485. | 446. | 410. | 377. | 346. | 318. | 293. | 269. | 247. | 228. |
| 209. | 192. | 177. | 163. | 149. | 137. | 126. | 116. | 107. | 98. |
| 90. | 83. | 76. | 70. | 64. | 59. | 54. | 50. | 46. | 42. |
| 39. | 36. | 33. | 30. | 28. | 26. | 24. | 22. | | |

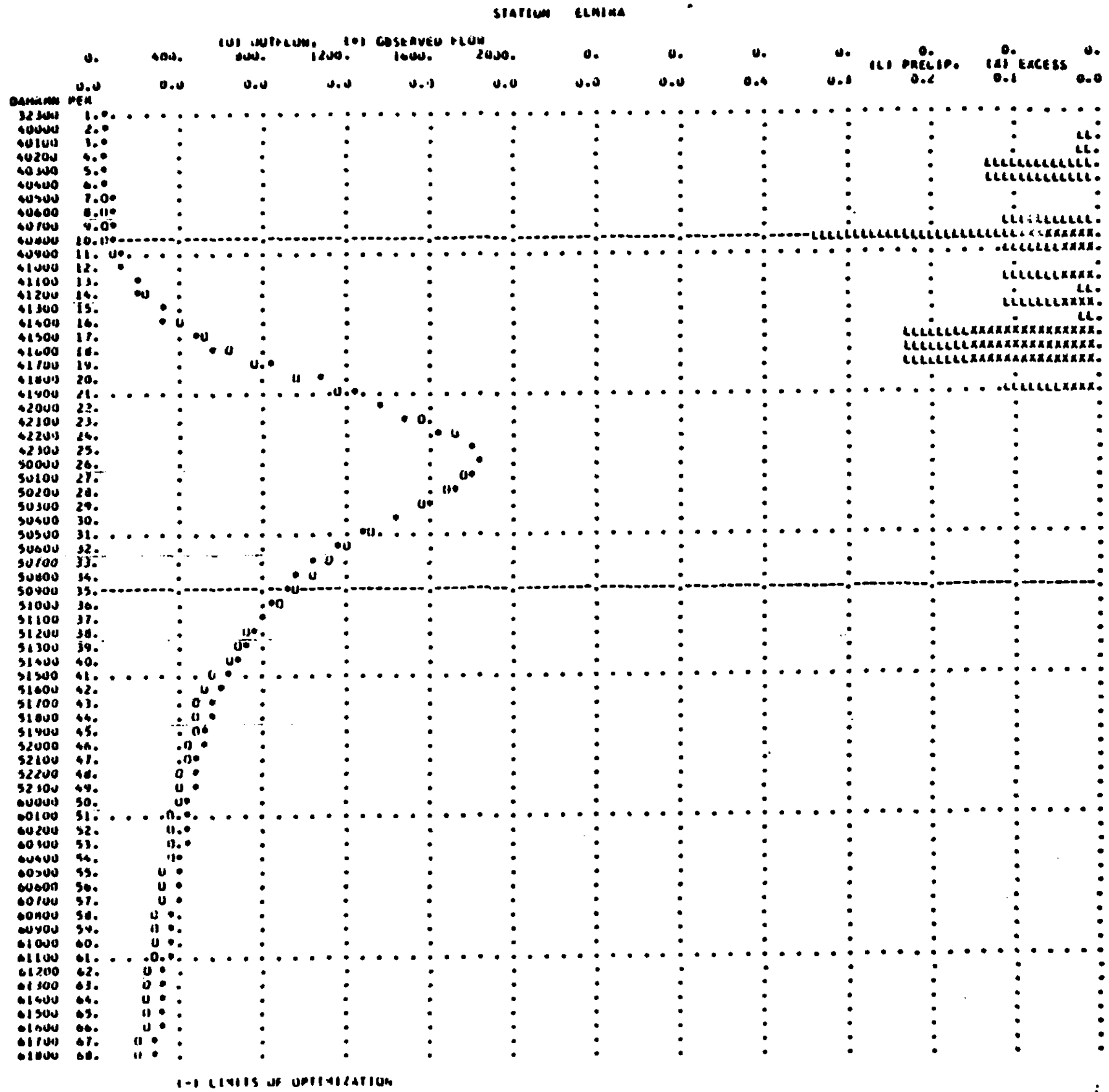
HYDROGRAPH AT STATION ELMIRA

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 3 NOV 2300 | 1 | 0.00 | 0.00 | 0.00 | 54. | 54. |
| 4 NOV 0000 | 2 | 0.00 | 0.00 | 0.00 | 52. | 54. |
| 4 NOV 0100 | 3 | 0.02 | 0.02 | 0.00 | 50. | 54. |
| 4 NOV 0200 | 4 | 0.02 | 0.02 | 0.00 | 49. | 55. |
| 4 NOV 0300 | 5 | 0.13 | 0.13 | 0.00 | 47. | 57. |
| 4 NOV 0400 | 6 | 0.13 | 0.13 | 0.00 | 46. | 58. |
| 4 NOV 0500 | 7 | 0.00 | 0.00 | 0.00 | 44. | 63. |
| 4 NOV 0600 | 8 | 0.00 | 0.00 | 0.00 | 43. | 66. |
| 4 NOV 0700 | 9 | 0.11 | 0.11 | 0.00 | 41. | 68. |
| 4 NOV 0800 | 10 | 0.34 | 0.25 | 0.09 | 49. | 89. |
| 4 NOV 0900 | 11 | 0.11 | 0.07 | 0.04 | 76. | 101. |
| 4 NOV 1000 | 12 | 0.00 | 0.00 | 0.00 | 122. | 138. |
| 4 NOV 1100 | 13 | 0.11 | 0.07 | 0.04 | 182. | 204. |
| 4 NOV 1200 | 14 | 0.02 | 0.02 | 0.00 | 256. | 212. |
| 4 NOV 1300 | 15 | 0.11 | 0.07 | 0.04 | 338. | 307. |
| 4 NOV 1400 | 16 | 0.02 | 0.02 | 0.00 | 419. | 329. |
| 4 NOV 1500 | 17 | 0.23 | 0.07 | 0.15 | 507. | 465. |
| 4 NOV 1600 | 18 | 0.23 | 0.07 | 0.15 | 622. | 571. |
| 4 NOV 1700 | 19 | 0.23 | 0.07 | 0.15 | 773. | 853. |
| 4 NOV 1800 | 20 | 0.00 | 0.00 | 0.00 | 954. | 1083. |
| 4 NOV 1900 | 21 | 0.11 | 0.07 | 0.04 | 1161. | 1248. |
| 4 NOV 2000 | 22 | 0.00 | 0.00 | 0.00 | 1374. | 1368. |
| 4 NOV 2100 | 23 | 0.00 | 0.00 | 0.00 | 1568. | 1497. |
| 4 NOV 2200 | 24 | 0.00 | 0.00 | 0.00 | 1719. | 1653. |
| 4 NOV 2300 | 25 | 0.00 | 0.00 | 0.00 | 1810. | 1785. |
| 5 NOV 0000 | 26 | 0.00 | 0.00 | 0.00 | 1829. | 1842. |
| 5 NOV 0100 | 27 | 0.00 | 0.00 | 0.00 | 1776. | 1800. |
| 5 NOV 0200 | 28 | 0.00 | 0.00 | 0.00 | 1674. | 1710. |
| 5 NOV 0300 | 29 | 0.00 | 0.00 | 0.00 | 1554. | 1596. |
| 5 NOV 0400 | 30 | 0.00 | 0.00 | 0.00 | 1436. | 1446. |
| 5 NOV 0500 | 31 | 0.00 | 0.00 | 0.00 | 1321. | 1296. |
| 5 NOV 0600 | 32 | 0.00 | 0.00 | 0.00 | 1215. | 1161. |
| 5 NOV 0700 | 33 | 0.00 | 0.00 | 0.00 | 1118. | 1053. |
| 5 NOV 0800 | 34 | 0.00 | 0.00 | 0.00 | 1029. | 969. |
| 5 NOV 0900 | 35 | 0.00 | 0.00 | 0.00 | 947. | 900. |
| 5 NOV 1000 | 36 | 0.00 | 0.00 | 0.00 | 871. | 844. |
| 5 NOV 1100 | 37 | 0.00 | 0.00 | 0.00 | 802. | 796. |
| 5 NOV 1200 | 38 | 0.00 | 0.00 | 0.00 | 738. | 754. |
| 5 NOV 1300 | 39 | 0.00 | 0.00 | 0.00 | 679. | 718. |
| 5 NOV 1400 | 40 | 0.00 | 0.00 | 0.00 | 625. | 679. |
| 5 NOV 1500 | 41 | 0.00 | 0.00 | 0.00 | 575. | 637. |
| 5 NOV 1600 | 42 | 0.00 | 0.00 | 0.00 | 530. | 599. |
| 5 NOV 1700 | 43 | 0.00 | 0.00 | 0.00 | 495. | 571. |
| 5 NOV 1800 | 44 | 0.00 | 0.00 | 0.00 | 478. | 542. |
| 5 NOV 1900 | 45 | 0.00 | 0.00 | 0.00 | 462. | 525. |
| 5 NOV 2000 | 46 | 0.00 | 0.00 | 0.00 | 447. | 506. |
| 5 NOV 2100 | 47 | 0.00 | 0.00 | 0.00 | 432. | 486. |
| 5 NOV 2200 | 48 | 0.00 | 0.00 | 0.00 | 418. | 475. |
| 5 NOV 2300 | 49 | 0.00 | 0.00 | 0.00 | 404. | 465. |
| 6 NOV 0000 | 50 | 0.00 | 0.00 | 0.00 | 390. | 451. |
| 6 NOV 0100 | 51 | 0.00 | 0.00 | 0.00 | 377. | 439. |
| 6 NOV 0200 | 52 | 0.00 | 0.00 | 0.00 | 364. | 428. |
| 6 NOV 0300 | 53 | 0.00 | 0.00 | 0.00 | 352. | 420. |
| 6 NOV 0400 | 54 | 0.00 | 0.00 | 0.00 | 341. | 409. |
| 6 NOV 0500 | 55 | 0.00 | 0.00 | 0.00 | 329. | 400. |
| 6 NOV 0600 | 56 | 0.00 | 0.00 | 0.00 | 318. | 391. |
| 6 NOV 0700 | 57 | 0.00 | 0.00 | 0.00 | 307. | 381. |
| 6 NOV 0800 | 58 | 0.00 | 0.00 | 0.00 | 297. | 373. |
| 6 NOV 0900 | 59 | 0.00 | 0.00 | 0.00 | 287. | 367. |
| 6 NOV 1000 | 60 | 0.00 | 0.00 | 0.00 | 278. | 356. |
| 6 NOV 1100 | 61 | 0.00 | 0.00 | 0.00 | 266. | 340. |
| 6 NOV 1200 | 62 | 0.00 | 0.00 | 0.00 | 259. | 329. |
| 6 NOV 1300 | 63 | 0.00 | 0.00 | 0.00 | 251. | 323. |
| 6 NOV 1400 | 64 | 0.00 | 0.00 | 0.00 | 242. | 316. |
| 6 NOV 1500 | 65 | 0.00 | 0.00 | 0.00 | 234. | 310. |
| 6 NOV 1600 | 66 | 0.00 | 0.00 | 0.00 | 226. | 303. |
| 6 NOV 1700 | 67 | 0.00 | 0.00 | 0.00 | 219. | 299. |
| 6 NOV 1800 | 68 | 0.00 | 0.00 | 0.00 | 212. | 292. |

TOTAL RAINFALL = 1.93, TOTAL LOSS = 1.21, TOTAL EXCESS = 0.71

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 67.00-HR |
|---|---|---|---|---|---|---|
| 1829. | 25.00 | (CFS) | 1728. | 1172. | 592. | 592. |
| | | (INCHES) | 0.207 | 0.563 | 0.792 | 0.792 |
| | | (AC-FT) | 857. | 2325. | 3275. | 3275. |

CUMULATIVE AREA = 77.53 SQ MI


STATION ELMIRA
(O) OUTFLOW, (*) OBSERVED FLOW
0. 400. 800. 1200. 1600. 2000.
(L) PRECIP. (X) EXCESS
DAHRMN PER
(-) LIMITS OF OPTIMIZATION

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        NEWTOWN CREEK 11-08-77
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3           IT      60 07NOV77    0500      68
  4           IO       1       2
  5           OU       1      40
  6           PG      EL     .74
  7           PG      SP    1.29
  8           PG      AF
  9           PI     .10     .00     .00     .10     .00     .10     .00     .00     .20     .00
 10           PI     .10     .00     .10     .10     .10     .00     .00     .00     .00     .00
 11           PI     .00     .00     .20     .20     .10     .00     .00     .00     .00     .00
 12           PG     HOR
 13           PI     .10     .00     .00     .10     .10     .10     .00     .00     .10     .00
 14           PI     .00     .10     .00     .00     .00     .00     .00     .00     .00     .10
 15           PI     .10     .10     .10     .10     .00     .00     .00     .00     .00     .00

 16           KK  ELMIRA
 17           QO     248     246     246     246     248     256     270     290     321     349
 18           QO     391     477     560     656     816     939     981     984     984     972
 19           QO     945     894     836     777     760     766     930    1062    1200    1296
 20           QO    1383    1428    1434    1392    1267    1158    1048     942     856     799
 21           QO     752     712     679     651     628     607     589     565     542     525
 22           QO     508     501     492     480     468     452     444     431     417     406
 23           QO     398     389     382     376     367     360     354     349       0       0
 24           PT      EL      SP      AF     HCK
 25           PW     .46     .06     .47     .01
 26           PR      AF     HOR
 27           PW     .85     .15
 28           BA    77.5      0.
 29           BF    248.    410.  1.0346
 30           UC     -8.    -15.
 31           LU    -.50    -.05
 32           ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 1 THROUGH 40)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.736 | | 17.04 | | | |
| COMPUTED HYDROGRAPH | 31599. | 0.632 | 790. | 25.24 | 8.20 | 1351. | 31.00 |
| OBSERVED HYDROGRAPH | 31697. | 0.634 | 792. | 25.16 | 8.11 | 1434. | 32.00 |
| DIFFERENCE | -98. | -0.002 | -2. | 0.08 | 0.08 | -83. | -1.00 |
| PERCENT DIFFERENCE | -0.31 | | | | 1.05 | -5.79 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 81. | AVERAGE ABSOLUTE ERROR | 62. |
| OBJECTIVE FUNCTION | 85. | AVERAGE PERCENT ABSOLUTE ERROR | 8.22 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 68)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.736 | | 17.04 | | | |
| COMPUTED HYDROGRAPH | 43047. | 0.861 | 633. | 32.25 | 15.21 | 1351. | 31.00 |
| OBSERVED HYDROGRAPH | 45521. | 0.910 | 669. | 33.52 | 16.47 | 1434. | 32.00 |
| DIFFERENCE | -2474. | -0.049 | -36. | -1.27 | -1.27 | -83. | -1.00 |
| PERCENT DIFFERENCE | -5.44 | | | | -7.69 | -5.79 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 87. | AVERAGE ABSOLUTE ERROR | 72. |
| OBJECTIVE FUNCTION | 90. | AVERAGE PERCENT ABSOLUTE ERROR | 13.13 |

UNIT HYDROGRAPH
82 END-OF-PERIOD ORDINATES

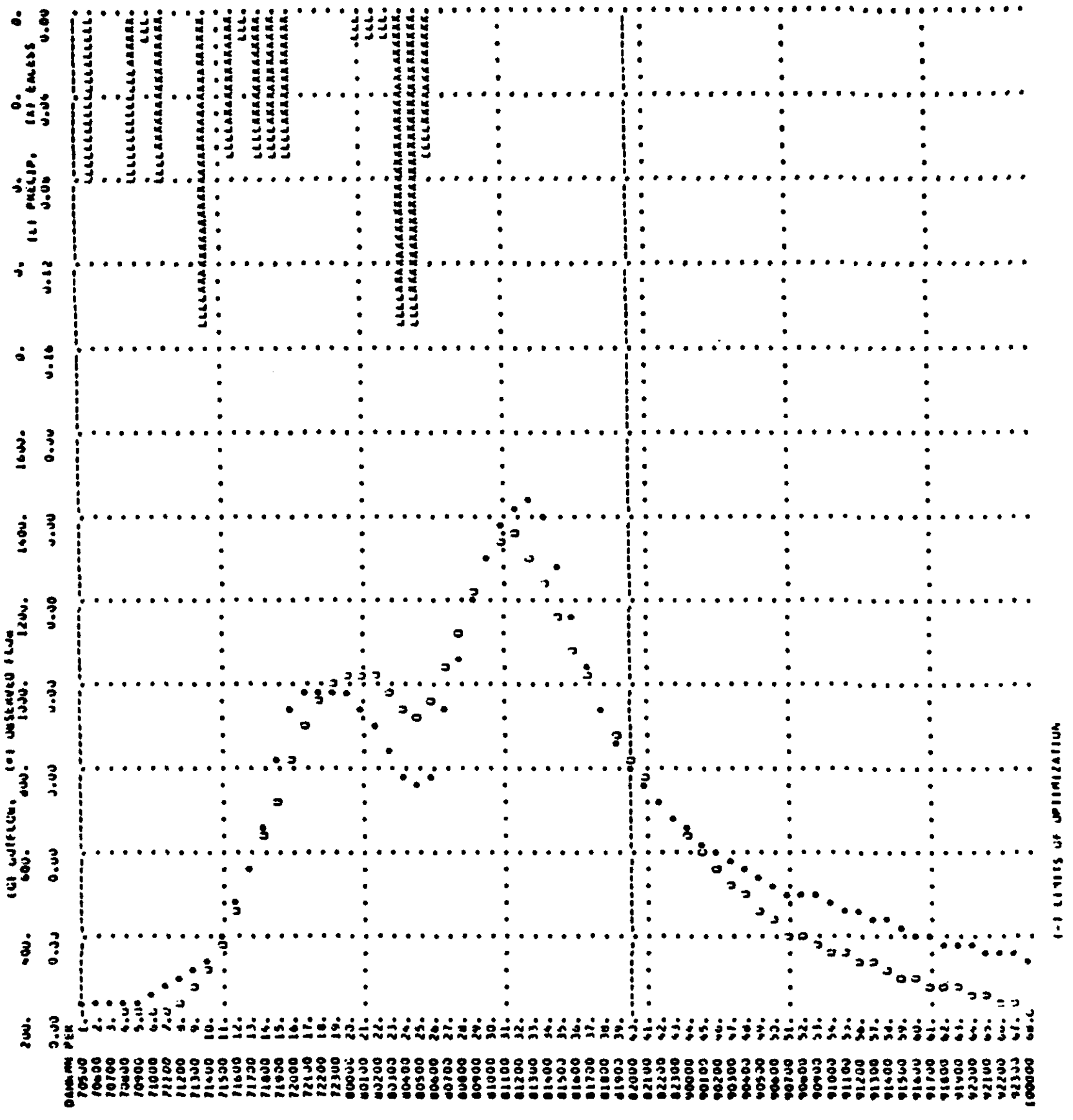
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 96. | 363. | 743. | 1192. | 1667. | 2087. | 2394. | 2571. | 2562. | 2417. |
| 2250. | 2106. | 1966. | 1835. | 1713. | 1599. | 1493. | 1394. | 1301. | 1214. |
| 1134. | 1058. | 988. | 922. | 861. | 803. | 750. | 700. | 654. | 610. |
| 570. | 532. | 496. | 463. | 432. | 404. | 377. | 352. | 328. | 307. |
| 286. | 267. | 249. | 233. | 217. | 203. | 189. | 177. | 165. | 154. |
| 144. | 134. | 125. | 117. | 109. | 102. | 95. | 89. | 83. | 77. |
| 72. | 67. | 63. | 59. | 55. | 51. | 48. | 45. | 42. | 39. |
| 36. | 34. | 32. | 30. | 28. | 26. | 24. | 22. | 21. | 20. |
| 18. | 17. | | | | | | | | |

HYDROGRAPH AT STATION ELMIRA

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 NOV 0500 | 1 | 0.00 | 0.00 | 0.00 | 248. | 248. | 8 NOV 1500 | 35 | 0.00 | 0.00 | 0.00 | 1155. | 1287. |
| 7 NOV 0600 | 2 | 0.00 | 0.00 | 0.00 | 240. | 246. | 8 NOV 1600 | 36 | 0.00 | 0.00 | 0.00 | 1081. | 1158. |
| 7 NOV 0700 | 3 | 0.00 | 0.00 | 0.00 | 232. | 246. | 8 NOV 1700 | 37 | 0.00 | 0.00 | 0.00 | 1012. | 1048. |
| 7 NOV 0800 | 4 | 0.00 | 0.00 | 0.00 | 224. | 246. | 8 NOV 1800 | 38 | 0.00 | 0.00 | 0.00 | 947. | 942. |
| 7 NOV 0900 | 5 | 0.08 | 0.06 | 0.02 | 219. | 248. | 8 NOV 1900 | 39 | 0.00 | 0.00 | 0.00 | 886. | 858. |
| 7 NOV 1000 | 6 | 0.01 | 0.01 | 0.00 | 218. | 256. | 8 NOV 2000 | 40 | 0.00 | 0.00 | 0.00 | 829. | 799. |
| 7 NOV 1100 | 7 | 0.08 | 0.02 | 0.06 | 226. | 270. | 8 NOV 2100 | 41 | 0.00 | 0.00 | 0.00 | 776. | 752. |
| 7 NOV 1200 | 8 | 0.00 | 0.00 | 0.00 | 247. | 290. | 8 NOV 2200 | 42 | 0.00 | 0.00 | 0.00 | 727. | 712. |
| 7 NOV 1300 | 9 | 0.00 | 0.00 | 0.00 | 275. | 321. | 8 NOV 2300 | 43 | 0.00 | 0.00 | 0.00 | 680. | 679. |
| 7 NOV 1400 | 10 | 0.15 | 0.02 | 0.13 | 323. | 349. | 9 NOV 0000 | 44 | 0.00 | 0.00 | 0.00 | 637. | 651. |
| 7 NOV 1500 | 11 | 0.00 | 0.00 | 0.00 | 386. | 391. | 9 NOV 0100 | 45 | 0.00 | 0.00 | 0.00 | 597. | 628. |
| 7 NOV 1600 | 12 | 0.07 | 0.02 | 0.05 | 466. | 477. | 9 NOV 0200 | 46 | 0.00 | 0.00 | 0.00 | 559. | 607. |
| 7 NOV 1700 | 13 | 0.01 | 0.01 | 0.00 | 552. | 563. | 9 NOV 0300 | 47 | 0.00 | 0.00 | 0.00 | 523. | 589. |
| 7 NOV 1800 | 14 | 0.07 | 0.02 | 0.05 | 641. | 656. | 9 NOV 0400 | 48 | 0.00 | 0.00 | 0.00 | 490. | 565. |
| 7 NOV 1900 | 15 | 0.07 | 0.02 | 0.05 | 727. | 816. | 9 NOV 0500 | 49 | 0.00 | 0.00 | 0.00 | 459. | 542. |
| 7 NOV 2000 | 16 | 0.07 | 0.02 | 0.05 | 812. | 939. | 9 NOV 0600 | 50 | 0.00 | 0.00 | 0.00 | 430. | 525. |
| 7 NOV 2100 | 17 | 0.00 | 0.00 | 0.00 | 894. | 981. | 9 NOV 0700 | 51 | 0.00 | 0.00 | 0.00 | 407. | 508. |
| 7 NOV 2200 | 18 | 0.00 | 0.00 | 0.00 | 958. | 984. | 9 NOV 0800 | 52 | 0.00 | 0.00 | 0.00 | 393. | 501. |
| 7 NOV 2300 | 19 | 0.00 | 0.00 | 0.00 | 1000. | 984. | 9 NOV 0900 | 53 | 0.00 | 0.00 | 0.00 | 380. | 492. |
| 8 NOV 0000 | 20 | 0.00 | 0.00 | 0.00 | 1025. | 972. | 9 NOV 1000 | 54 | 0.00 | 0.00 | 0.00 | 367. | 480. |
| 8 NOV 0100 | 21 | 0.01 | 0.01 | 0.00 | 1029. | 945. | 9 NOV 1100 | 55 | 0.00 | 0.00 | 0.00 | 355. | 468. |
| 8 NOV 0200 | 22 | 0.01 | 0.01 | 0.00 | 1013. | 894. | 9 NOV 1200 | 56 | 0.00 | 0.00 | 0.00 | 343. | 452. |
| 8 NOV 0300 | 23 | 0.01 | 0.01 | 0.00 | 976. | 836. | 9 NOV 1300 | 57 | 0.00 | 0.00 | 0.00 | 332. | 444. |
| 8 NOV 0400 | 24 | 0.15 | 0.02 | 0.13 | 937. | 777. | 9 NOV 1400 | 58 | 0.00 | 0.00 | 0.00 | 320. | 431. |
| 8 NOV 0500 | 25 | 0.15 | 0.02 | 0.13 | 929. | 760. | 9 NOV 1500 | 59 | 0.00 | 0.00 | 0.00 | 310. | 417. |
| 8 NOV 0600 | 26 | 0.07 | 0.02 | 0.05 | 964. | 788. | 9 NOV 1600 | 60 | 0.00 | 0.00 | 0.00 | 299. | 408. |
| 8 NOV 0700 | 27 | 0.00 | 0.00 | 0.00 | 1036. | 930. | 9 NOV 1700 | 61 | 0.00 | 0.00 | 0.00 | 289. | 398. |
| 8 NOV 0800 | 28 | 0.00 | 0.00 | 0.00 | 1129. | 1062. | 9 NOV 1800 | 62 | 0.00 | 0.00 | 0.00 | 280. | 389. |
| 8 NOV 0900 | 29 | 0.00 | 0.00 | 0.00 | 1225. | 1200. | 9 NOV 1900 | 63 | 0.00 | 0.00 | 0.00 | 270. | 382. |
| 8 NOV 1000 | 30 | 0.00 | 0.00 | 0.00 | 1304. | 1296. | 9 NOV 2000 | 64 | 0.00 | 0.00 | 0.00 | 261. | 376. |
| 8 NOV 1100 | 31 | 0.00 | 0.00 | 0.00 | 1350. | 1383. | 9 NOV 2100 | 65 | 0.00 | 0.00 | 0.00 | 253. | 367. |
| 8 NOV 1200 | 32 | 0.00 | 0.00 | 0.00 | 1351. | 1428. | 9 NOV 2200 | 66 | 0.00 | 0.00 | 0.00 | 244. | 360. |
| 8 NOV 1300 | 33 | 0.00 | 0.00 | 0.00 | 1306. | 1434. | 9 NOV 2300 | 67 | 0.00 | 0.00 | 0.00 | 236. | 354. |
| 8 NOV 1400 | 34 | 0.00 | 0.00 | 0.00 | 1233. | 1392. | 10 NOV 0000 | 68 | 0.00 | 0.00 | 0.00 | 228. | 349. |

TOTAL RAINFALL = 1.09, TOTAL LOSS = 0.35, TOTAL EXCESS = 0.74

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 67.00-HR |
|---|---|---|---|---|---|---|
| 1351. | 31.00 | (CFS) | 1289. | 1065. | 639. | 639. |
| | | (INCHES) | 0.155 | 0.511 | 0.856 | 0.856 |
| | | (AC-FT) | 639. | 2112. | 3538. | 3538. |



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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1      ID        NEWTOWN CREEK 11-11-77
   2      ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
   3      IT      60 10NOV77    1300      48
   4      IO       1       2
   5      OU       5      25
   6      PG      EL     .50
   7      PG      SP     .91
   8      PG      AF
   9      PI     .00     .00     .10     .10     .10     .20     .00     .10     .10     .20
  10      PI     .00     .10     .00     .00     .00     .00     .00     .00     .00     .00
  11      PG     HOR
  12      PI     .00     .10     .00     .10     .10     .10     .10     .10     .00     .00
  13      PI     .10     .00     .00     .00     .00     .00     .00     .00     .00     .00

  14      KK  ELMIRA
  15      QO     288     285     282     277     277     282     294     321     362     422
  16      QO     584     830    1026    1134    1206    1278    1311    1311    1284    1224
  17      QO    1116     993     880     794     726     676     637     602     591     555
  18      QO     537     520     508     494     480     468     451     437     424     415
  19      QO     404     398     389     382     375     367     360     354       0       0
  20      PT      EL      SP      AF     HOR
  21      PW     .46     .06     .47     .01
  22      PR      AF     HOR
  23      PW     .85     .15
  24      BA    77.5      0.
  25      BF    266.    410.  1.0346
  26      UC     -8.    -15.
  27      LU    -.09    -.01
  28      ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 5 THROUGH 25)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.457 | | 9.24 | | | |
| COMPUTED HYDROGRAPH | 17652. | 0.353 | 841. | 16.90 | 7.66 | 1287. | 16.00 |
| OBSERVED HYDROGRAPH | 17655. | 0.353 | 841. | 16.81 | 7.57 | 1311. | 16.00 |
| DIFFERENCE | -3. | -0.000 | -0. | 0.08 | 0.08 | -24. | 0.00 |
| PERCENT DIFFERENCE | -0.02 | | | | 1.11 | -1.81 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 51. | AVERAGE ABSOLUTE ERROR | 44. |
| OBJECTIVE FUNCTION | 51. | AVERAGE PERCENT ABSOLUTE ERROR | 6.62 |

### STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 48)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.457 | | 9.24 | | | |
| COMPUTED HYDROGRAPH | 28841. | 0.577 | 601. | 22.64 | 13.40 | 1287. | 16.00 |
| OBSERVED HYDROGRAPH | 29611. | 0.592 | 617. | 23.18 | 13.94 | 1311. | 16.00 |
| DIFFERENCE | -770. | -0.015 | -16. | -0.54 | -0.54 | -24. | 0.00 |
| PERCENT DIFFERENCE | -2.60 | | | | -3.87 | -1.81 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 56. | AVERAGE ABSOLUTE ERROR | 48. |
| OBJECTIVE FUNCTION | 57. | AVERAGE PERCENT ABSOLUTE ERROR | 10.29 |

UNIT HYDROGRAPH
76 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 119. | 431. | 882. | 1412. | 1947. | 2387. | 2680. | 2780. | 2673. | 2482. |
| 2304. | 2140. | 1987. | 1845. | 1713. | 1590. | 1476. | 1371. | 1273. | 1182. |
| 1097. | 1019. | 946. | 878. | 816. | 757. | 703. | 653. | 606. | 563. |
| 523. | 485. | 450. | 418. | 388. | 361. | 335. | 311. | 289. | 268. |
| 249. | 231. | 215. | 199. | 185. | 172. | 159. | 148. | 137. | 128. |
| 119. | 110. | 102. | 95. | 88. | 82. | 76. | 70. | 65. | 61. |
| 56. | 52. | 49. | 45. | 42. | 39. | 36. | 34. | 31. | 29. |
| 27. | 25. | 23. | 22. | 20. | 19. | | | | |

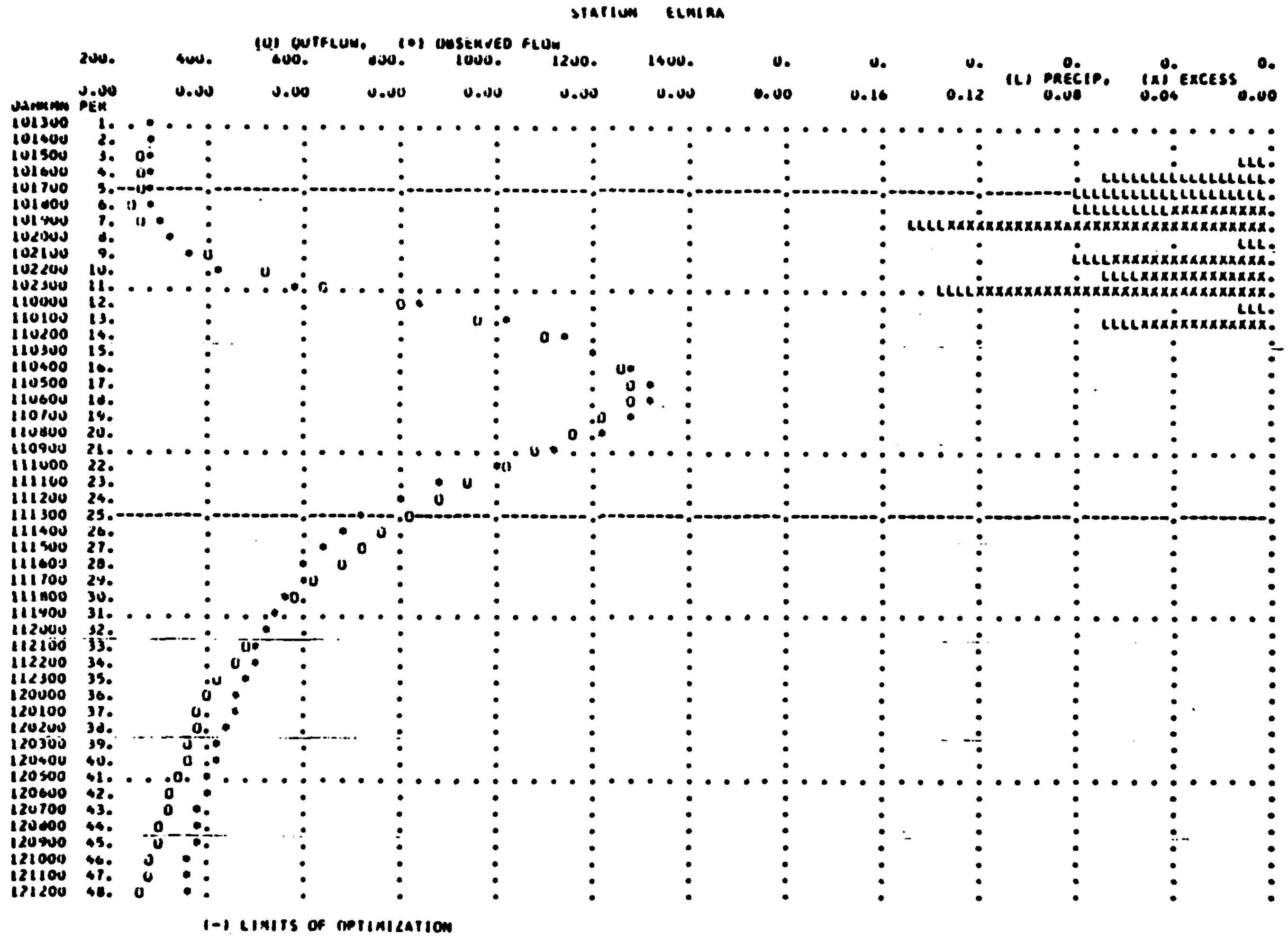
HYDROGRAPH AT STATION ELMIRA

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 NOV 1300 | 1 | 0.00 | 0.00 | 0.00 | 288. | 288. | 11 NOV 1300 | 25 | 0.00 | 0.00 | 0.00 | 823. | 726. |
| 10 NOV 1400 | 2 | 0.00 | 0.00 | 0.00 | 278. | 285. | 11 NOV 1400 | 26 | 0.00 | 0.00 | 0.00 | 769. | 676. |
| 10 NOV 1500 | 3 | 0.01 | 0.01 | 0.00 | 269. | 282. | 11 NOV 1500 | 27 | 0.00 | 0.00 | 0.00 | 719. | 637. |
| 10 NOV 1600 | 4 | 0.07 | 0.07 | 0.00 | 260. | 277. | 11 NOV 1600 | 28 | 0.00 | 0.00 | 0.00 | 672. | 602. |
| 10 NOV 1700 | 5 | 0.08 | 0.08 | 0.00 | 251. | 277. | 11 NOV 1700 | 29 | 0.00 | 0.00 | 0.00 | 628. | 591. |
| 10 NOV 1800 | 6 | 0.08 | 0.04 | 0.04 | 248. | 282. | 11 NOV 1800 | 30 | 0.00 | 0.00 | 0.00 | 588. | 555. |
| 10 NOV 1900 | 7 | 0.15 | 0.02 | 0.13 | 268. | 294. | 11 NOV 1900 | 31 | 0.00 | 0.00 | 0.00 | 550. | 537. |
| 10 NOV 2000 | 8 | 0.01 | 0.01 | 0.00 | 320. | 321. | 11 NOV 2000 | 32 | 0.00 | 0.00 | 0.00 | 514. | 520. |
| 10 NOV 2100 | 9 | 0.08 | 0.02 | 0.06 | 400. | 362. | 11 NOV 2100 | 33 | 0.00 | 0.00 | 0.00 | 481. | 508. |
| 10 NOV 2200 | 10 | 0.07 | 0.02 | 0.05 | 510. | 422. | 11 NOV 2200 | 34 | 0.00 | 0.00 | 0.00 | 451. | 494. |
| 10 NOV 2300 | 11 | 0.14 | 0.02 | 0.12 | 650. | 584. | 11 NOV 2300 | 35 | 0.00 | 0.00 | 0.00 | 422. | 480. |
| 11 NOV 0000 | 12 | 0.01 | 0.01 | 0.00 | 807. | 830. | 12 NOV 0000 | 36 | 0.00 | 0.00 | 0.00 | 402. | 468. |
| 11 NOV 0100 | 13 | 0.07 | 0.02 | 0.05 | 963. | 1026. | 12 NOV 0100 | 37 | 0.00 | 0.00 | 0.00 | 389. | 451. |
| 11 NOV 0200 | 14 | 0.00 | 0.00 | 0.00 | 1100. | 1134. | 12 NOV 0200 | 38 | 0.00 | 0.00 | 0.00 | 376. | 437. |
| 11 NOV 0300 | 15 | 0.00 | 0.00 | 0.00 | 1200. | 1206. | 12 NOV 0300 | 39 | 0.00 | 0.00 | 0.00 | 363. | 424. |
| 11 NOV 0400 | 16 | 0.00 | 0.00 | 0.00 | 1262. | 1278. | 12 NOV 0400 | 40 | 0.00 | 0.00 | 0.00 | 351. | 415. |
| 11 NOV 0500 | 17 | 0.00 | 0.00 | 0.00 | 1287. | 1311. | 12 NOV 0500 | 41 | 0.00 | 0.00 | 0.00 | 339. | 404. |
| 11 NOV 0600 | 18 | 0.00 | 0.00 | 0.00 | 1271. | 1311. | 12 NOV 0600 | 42 | 0.00 | 0.00 | 0.00 | 328. | 398. |
| 11 NOV 0700 | 19 | 0.00 | 0.00 | 0.00 | 1221. | 1284. | 12 NOV 0700 | 43 | 0.00 | 0.00 | 0.00 | 317. | 389. |
| 11 NOV 0800 | 20 | 0.00 | 0.00 | 0.00 | 1154. | 1224. | 12 NOV 0800 | 44 | 0.00 | 0.00 | 0.00 | 307. | 382. |
| 11 NOV 0900 | 21 | 0.00 | 0.00 | 0.00 | 1082. | 1116. | 12 NOV 0900 | 45 | 0.00 | 0.00 | 0.00 | 296. | 375. |
| 11 NOV 1000 | 22 | 0.00 | 0.00 | 0.00 | 1010. | 993. | 12 NOV 1000 | 46 | 0.00 | 0.00 | 0.00 | 246. | 367. |
| 11 NOV 1100 | 23 | 0.00 | 0.00 | 0.00 | 943. | 880. | 12 NOV 1100 | 47 | 0.00 | 0.00 | 0.00 | 277. | 360. |
| 11 NOV 1200 | 24 | 0.00 | 0.00 | 0.00 | 881. | 794. | 12 NOV 1200 | 48 | 0.00 | 0.00 | 0.00 | 268. | 354. |

TOTAL RAINFALL = 0.76, TOTAL LOSS = 0.30, TOTAL EXCESS = 0.46

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 47.00-HR |
|---|---|---|---|---|---|---|
| 1287. | 16.00 | (CFS) | 1228. | 877. | 608. | 608. |
| | | (INCHES) | 0.147 | 0.421 | 0.571 | 0.571 |
| | | (AC-FT) | 609. | 1740. | 2361. | 2361. |

CUMULATIVE AREA = 77.50 SQ MI


STATION ELMIRA
(O) OUTFLOW, (*) OBSERVED FLOW
200. 400. 600. 800. 1000. 1200. 1400.
(L) PRECIP. (X) EXCESS
0.16 0.12 0.08 0.04 0.00
DAHRMN PER
(-) LIMITS OF OPTIMIZATION

HEC-1 INPUT                                                                  PAGE 1

```
LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1       ID        NEWTOWN CREEK 10-06-79
  2       ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3       IT      60 05OCT79    0700      48
  4       IO       1       2
  5       OU       5      30
  6       PG      EL    1.95
  7       PG      SP    2.35
  8       PG      AF
  9       PI     .00     .00     .10     .00     .10     .30     .10     .00     .10     .40
 10       PI     .10     .50     .00     .00     .40     .10     .10     .10     .00     .00
 11       PG     HOR
 12       PI     .10     .00     .00     .10     .20     .30     .10     .20     .10     .20
 13       PI     .10     .00     .10     .20     .10     .10     .00     .10     .00     .00

 14       KK  ELMIRA
 15       QO      41      41      41      41      42      46      57      63      77     102
 16       QO     155     419     745     946    1043    1103    1164    1186    1217    1277
 17       QO    1336    1375    1348    1262    1112     948     811     691     608     537
 18       QO     483     440     409     379     354     332     315     299     283     270
 19       QO     259     248     240     232     224     218     212     206       0       0
 20       PT      EL      SP      AF     HOR
 21       PW     .46     .06     .47     .01
 22       PR      AF     HOR
 23       PW     .85     .15
 24       BA    77.5      0.
 25       BF     41.    250.  1.0346
 26       UC    -9.0    -13.
 27       LU     -.5    -.08
 28       ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 5 THROUGH 30)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.656 | | 13.28 | | | |
| COMPUTED HYDROGRAPH | 19799. | 0.396 | 761. | 20.82 | 7.54 | 1424. | 17.00 |
| OBSERVED HYDROGRAPH | 19670. | 0.393 | 757. | 20.48 | 7.20 | 1375. | 21.00 |
| DIFFERENCE | 129. | 0.003 | 5. | 0.34 | 0.34 | 49. | -4.00 |
| PERCENT DIFFERENCE | 0.65 | | | | 4.66 | 3.57 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 130. | AVERAGE ABSOLUTE ERROR | 105. |
| OBJECTIVE FUNCTION | 140. | AVERAGE PERCENT ABSOLUTE ERROR | 21.81 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 48)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.656 | | 13.28 | | | |
| COMPUTED HYDROGRAPH | 28626. | 0.572 | 596. | 25.95 | 12.67 | 1424. | 17.00 |
| OBSERVED HYDROGRAPH | 25237. | 0.505 | 526. | 24.15 | 10.87 | 1375. | 21.00 |
| DIFFERENCE | 3389. | 0.068 | 71. | 1.80 | 1.80 | 49. | -4.00 |
| PERCENT DIFFERENCE | 13.43 | | | | 16.54 | 3.57 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 150. | AVERAGE ABSOLUTE ERROR | 125. |
| OBJECTIVE FUNCTION | 162. | AVERAGE PERCENT ABSOLUTE ERROR | 37.43 |

UNIT HYDROGRAPH
100 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 434. | 1506. | 2308. | 2408. | 2282. | 2162. | 2048. | 1940. | 1838. | 1741. |
| 1653. | 1563. | 1481. | 1403. | 1329. | 1259. | 1193. | 1130. | 1070. | 1014. |
| 961. | 910. | 862. | 817. | 774. | 733. | 695. | 658. | 623. | 591. |
| 565. | 533. | 502. | 476. | 451. | 427. | 405. | 383. | 363. | 344. |
| 326. | 309. | 292. | 277. | 263. | 249. | 236. | 223. | 211. | 200. |
| 190. | 180. | 170. | 161. | 153. | 145. | 137. | 130. | 123. | 117. |
| 111. | 105. | 99. | 94. | 89. | 84. | 80. | 76. | 72. | 68. |
| 64. | 61. | 58. | 55. | 52. | 49. | 47. | 44. | 42. | 40. |
| 37. | 36. | 34. | 32. | 30. | 29. | 27. | 26. | 24. | 23. |
| 22. | 21. | 20. | 19. | 18. | 17. | 16. | 15. | 14. | 13. |

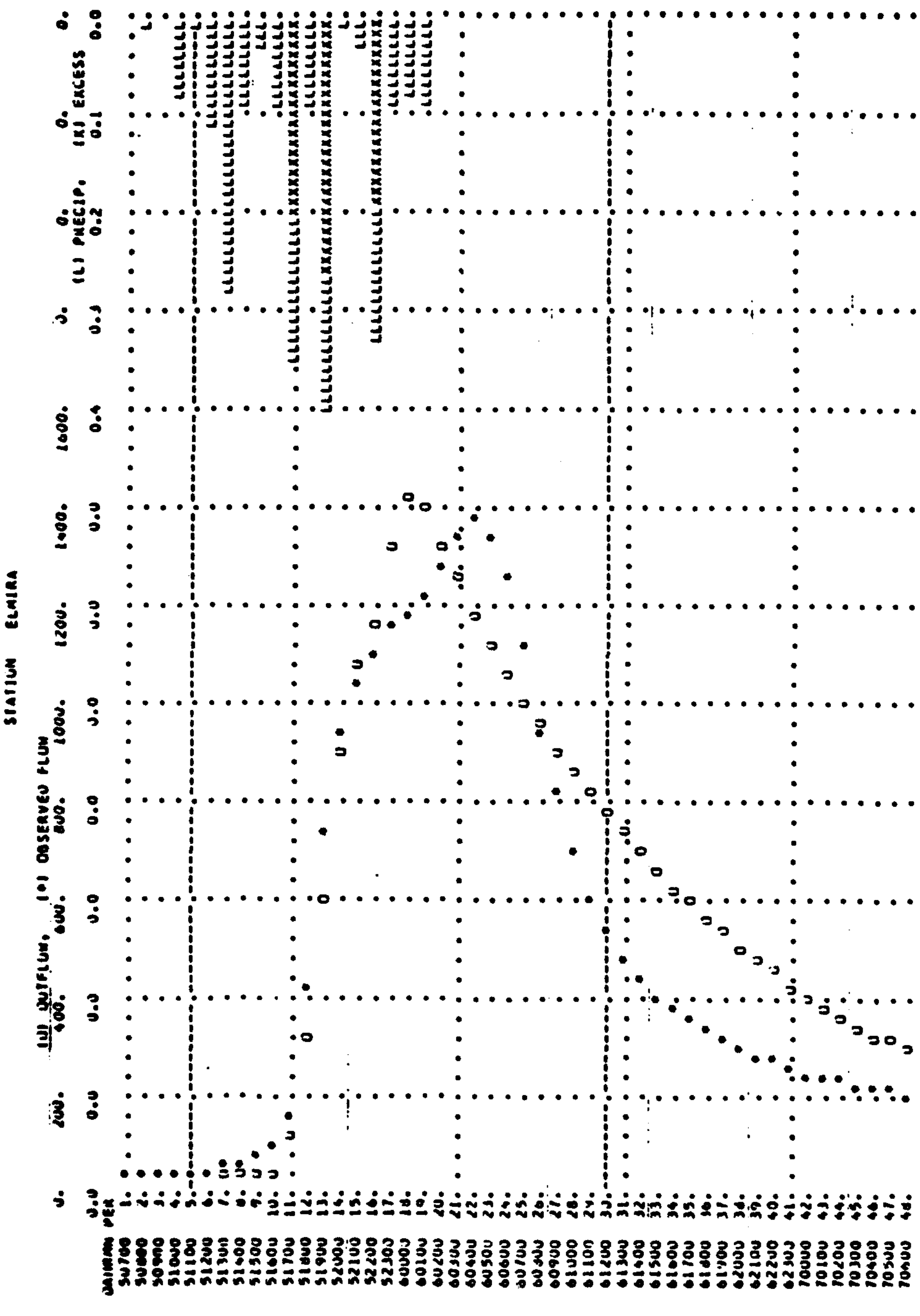
HYDROGRAPH AT STATION ELMIRA

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 OCT 0700 | 1 | 0.00 | 0.00 | 0.00 | 41. | 41. | 6 OCT 0700 | 25 | 0.00 | 0.00 | 0.00 | 1009. | 1112. |
| 5 OCT 0800 | 2 | 0.01 | 0.01 | 0.00 | 40. | 41. | 6 OCT 0800 | 26 | 0.00 | 0.00 | 0.00 | 956. | 948. |
| 5 OCT 0900 | 3 | 0.00 | 0.00 | 0.00 | 38. | 41. | 6 OCT 0900 | 27 | 0.00 | 0.00 | 0.00 | 906. | 811. |
| 5 OCT 1000 | 4 | 0.08 | 0.08 | 0.00 | 37. | 41. | 6 OCT 1000 | 28 | 0.00 | 0.00 | 0.00 | 859. | 691. |
| 5 OCT 1100 | 5 | 0.01 | 0.01 | 0.00 | 36. | 42. | 6 OCT 1100 | 29 | 0.00 | 0.00 | 0.00 | 814. | 608. |
| 5 OCT 1200 | 6 | 0.11 | 0.11 | 0.00 | 35. | 46. | 6 OCT 1200 | 30 | 0.00 | 0.00 | 0.00 | 772. | 537. |
| 5 OCT 1300 | 7 | 0.28 | 0.28 | 0.00 | 33. | 57. | 6 OCT 1300 | 31 | 0.00 | 0.00 | 0.00 | 731. | 483. |
| 5 OCT 1400 | 8 | 0.09 | 0.09 | 0.00 | 32. | 63. | 6 OCT 1400 | 32 | 0.00 | 0.00 | 0.00 | 693. | 440. |
| 5 OCT 1500 | 9 | 0.03 | 0.03 | 0.00 | 31. | 77. | 6 OCT 1500 | 33 | 0.00 | 0.00 | 0.00 | 657. | 409. |
| 5 OCT 1600 | 10 | 0.09 | 0.09 | 0.00 | 30. | 102. | 6 OCT 1600 | 34 | 0.00 | 0.00 | 0.00 | 623. | 379. |
| 5 OCT 1700 | 11 | 0.35 | 0.15 | 0.20 | 116. | 155. | 6 OCT 1700 | 35 | 0.00 | 0.00 | 0.00 | 590. | 354. |
| 5 OCT 1800 | 12 | 0.09 | 0.09 | 0.00 | 330. | 419. | 6 OCT 1800 | 36 | 0.00 | 0.00 | 0.00 | 559. | 332. |
| 5 OCT 1900 | 13 | 0.40 | 0.14 | 0.26 | 603. | 745. | 6 OCT 1900 | 37 | 0.00 | 0.00 | 0.00 | 530. | 315. |
| 5 OCT 2000 | 14 | 0.01 | 0.01 | 0.00 | 901. | 946. | 6 OCT 2000 | 38 | 0.00 | 0.00 | 0.00 | 502. | 299. |
| 5 OCT 2100 | 15 | 0.03 | 0.03 | 0.00 | 1083. | 1043. | 6 OCT 2100 | 39 | 0.00 | 0.00 | 0.00 | 476. | 283. |
| 5 OCT 2200 | 16 | 0.33 | 0.14 | 0.19 | 1169. | 1103. | 6 OCT 2200 | 40 | 0.00 | 0.00 | 0.00 | 451. | 270. |
| 5 OCT 2300 | 17 | 0.09 | 0.09 | 0.00 | 1321. | 1164. | 6 OCT 2300 | 41 | 0.00 | 0.00 | 0.00 | 428. | 259. |
| 6 OCT 0000 | 18 | 0.08 | 0.08 | 0.00 | 1424. | 1186. | 7 OCT 0000 | 42 | 0.00 | 0.00 | 0.00 | 405. | 248. |
| 6 OCT 0100 | 19 | 0.09 | 0.09 | 0.00 | 1393. | 1217. | 7 OCT 0100 | 43 | 0.00 | 0.00 | 0.00 | 384. | 240. |
| 6 OCT 0200 | 20 | 0.00 | 0.00 | 0.00 | 1320. | 1277. | 7 OCT 0200 | 44 | 0.00 | 0.00 | 0.00 | 364. | 232. |
| 6 OCT 0300 | 21 | 0.00 | 0.00 | 0.00 | 1251. | 1336. | 7 OCT 0300 | 45 | 0.00 | 0.00 | 0.00 | 345. | 224. |
| 6 OCT 0400 | 22 | 0.00 | 0.00 | 0.00 | 1185. | 1375. | 7 OCT 0400 | 46 | 0.00 | 0.00 | 0.00 | 327. | 218. |
| 6 OCT 0500 | 23 | 0.00 | 0.00 | 0.00 | 1123. | 1348. | 7 OCT 0500 | 47 | 0.00 | 0.00 | 0.00 | 310. | 212. |
| 6 OCT 0600 | 24 | 0.00 | 0.00 | 0.00 | 1065. | 1262. | 7 OCT 0600 | 48 | 0.00 | 0.00 | 0.00 | 294. | 206. |

TOTAL RAINFALL = 2.19, TOTAL LOSS = 1.53, TOTAL EXCESS = 0.66

| PEAK FLOW | TIME | | MAXIMUM AVERAGE FLOW | | | |
|---|---|---|---|---|---|---|
| (CFS) | (HR) | | 6-HR | 24-HR | 72-HR | 47.00-HR |
| 1424. | 17.00 | (CFS) | 1314. | 957. | 605. | 605. |
| | | (INCHES) | 0.158 | 0.459 | 0.569 | 0.569 |
| | | (AC-FT) | 652. | 1898. | 2352. | 2352. |

CUMULATIVE AREA = 77.50 SQ MI


STATION ELMIRA
(U) OUTFLOW, (O) OBSERVED FLOW
(L) PRECIP., (X) EXCESS
(-) LIMITS OF OPTIMIZATION

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID       NEWTOWN CREEK 11-26-79
  2           ID       UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3           IT      60 26NOV79    0600      41
  4           IO       1       2
  5           OU       1      25
  6           PG      EL    2.21
  7           PG      SP    1.59
  8           PG      AF
  9           PI     .00     .00     .10     .30     .30     .20     .20     .20     .20     .10
 10           PI     .00     .00     .10     .00     .00     .00     .00     .00     .00     .00
 11           PG     HOR
 12           PI     .00     .10     .40     .40     .40     .60     .10     .20     .00     .00
 13           PI     .00     .10     .00     .00     .00     .00     .00     .00     .00     .00

 14           KK  ELMIRA
 15           QO      78      77      79     118     155     467     805    1250    1381    1494
 16           QO    1652    1797    1911    2011    2099    2115    2036    1930    1763    1531
 17           QO    1295    1100     969     863     770     708     659     613     580     547
 18           QO     518     491     464     437     419     401     389     374     364     351
 19           QO     342       0       0       0       0       0       0       0       0       0
 20           PT      EL      SP      AF     HOR
 21           PW     .46     .06     .47     .01
 22           PR      AF     HOR
 23           PW     .85     .15
 24           BA    77.5      0.
 25           BF     78.    420.  1.0346
 26           UC    -10.    -13.
 27           LU     -.1    -.08
 28           ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 1 THROUGH 25)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.927 | | 6.69 | | | |
| COMPUTED HYDROGRAPH | 29709. | 0.594 | 1188. | 15.66 | 8.97 | 2081. | 12.00 |
| OBSERVED HYDROGRAPH | 29746. | 0.595 | 1190. | 15.22 | 8.53 | 2115. | 15.00 |
| DIFFERENCE | -37. | -0.001 | -1. | 0.44 | 0.44 | -34. | -3.00 |
| PERCENT DIFFERENCE | -0.12 | | | | 5.17 | -1.60 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 205. | AVERAGE ABSOLUTE ERROR | 171. |
| OBJECTIVE FUNCTION | 211. | AVERAGE PERCENT ABSOLUTE ERROR | 17.06 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 41)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.927 | | 6.69 | | | |
| COMPUTED HYDROGRAPH | 41019. | 0.820 | 1000. | 20.25 | 13.56 | 2081. | 12.00 |
| OBSERVED HYDROGRAPH | 37403. | 0.748 | 912. | 18.75 | 12.06 | 2115. | 15.00 |
| DIFFERENCE | 3616. | 0.072 | 88. | 1.50 | 1.50 | -34. | -3.00 |
| PERCENT DIFFERENCE | 9.67 | | | | 12.44 | -1.60 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 219. | AVERAGE ABSOLUTE ERROR | 194. |
| OBJECTIVE FUNCTION | 231. | AVERAGE PERCENT ABSOLUTE ERROR | 28.59 |

UNIT HYDROGRAPH
94 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 144. | 541. | 1112. | 1714. | 2185. | 2406. | 2371. | 2237. | 2111. | 1991. |
| 1879. | 1772. | 1672. | 1577. | 1488. | 1404. | 1324. | 1250. | 1179. | 1112. |
| 1049. | 990. | 934. | 881. | 831. | 784. | 743. | 698. | 658. | 621. |
| 586. | 553. | 522. | 492. | 464. | 438. | 413. | 390. | 368. | 347. |
| 327. | 309. | 291. | 275. | 259. | 245. | 231. | 218. | 205. | 194. |
| 183. | 172. | 163. | 153. | 145. | 137. | 129. | 122. | 115. | 108. |
| 102. | 96. | 91. | 86. | 81. | 76. | 72. | 68. | 64. | 60. |
| 57. | 54. | 51. | 48. | 45. | 43. | 40. | 38. | 36. | 34. |
| 32. | 30. | 28. | 27. | 25. | 24. | 22. | 21. | 20. | 19. |
| 18. | 17. | 16. | 15. | | | | | | |

HYDROGRAPH AT STATION ELMIRA

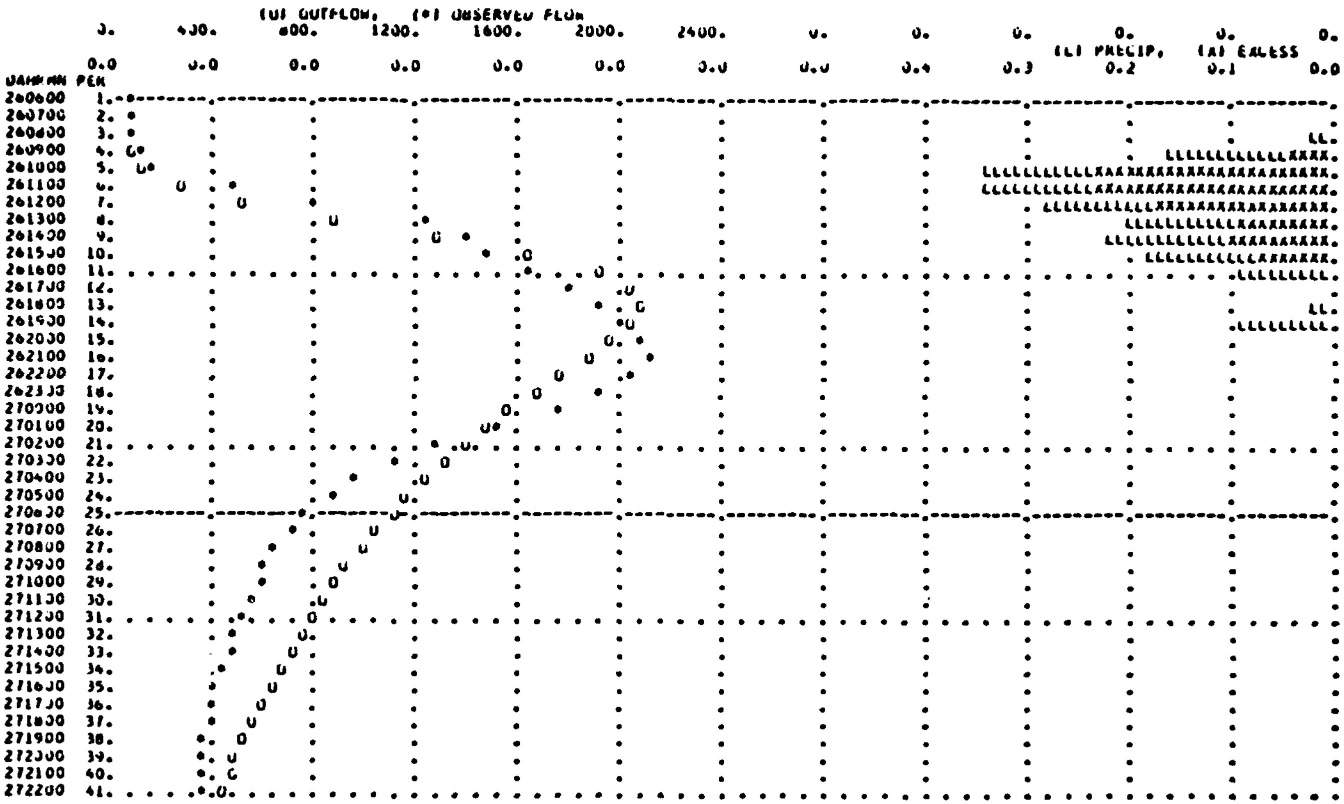
| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 26 NOV 0600 | 1 | 0.00 | 0.00 | 0.00 | 78. | 76. |
| 26 NOV 0700 | 2 | 0.00 | 0.00 | 0.00 | 75. | 77. |
| 26 NOV 0800 | 3 | 0.02 | 0.02 | 0.00 | 73. | 79. |
| 26 NOV 0900 | 4 | 0.16 | 0.12 | 0.04 | 76. | 118. |
| 26 NOV 1000 | 5 | 0.34 | 0.11 | 0.23 | 122. | 155. |
| 26 NOV 1100 | 6 | 0.34 | 0.11 | 0.23 | 265. | 467. |
| 26 NOV 1200 | 7 | 0.28 | 0.11 | 0.17 | 531. | 805. |
| 26 NOV 1300 | 8 | 0.20 | 0.11 | 0.09 | 894. | 1250. |
| 26 NOV 1400 | 9 | 0.22 | 0.11 | 0.10 | 1292. | 1381. |
| 26 NOV 1500 | 10 | 0.18 | 0.11 | 0.07 | 1649. | 1494. |
| 26 NOV 1600 | 11 | 0.09 | 0.09 | 0.00 | 1905. | 1652. |
| 26 NOV 1700 | 12 | 0.00 | 0.00 | 0.00 | 2042. | 1797. |
| 26 NOV 1800 | 13 | 0.02 | 0.02 | 0.00 | 2081. | 1911. |
| 26 NOV 1900 | 14 | 0.09 | 0.09 | 0.00 | 2050. | 2011. |
| 26 NOV 2000 | 15 | 0.00 | 0.00 | 0.00 | 1970. | 2099. |
| 26 NOV 2100 | 16 | 0.00 | 0.00 | 0.00 | 1867. | 2115. |
| 26 NOV 2200 | 17 | 0.00 | 0.00 | 0.00 | 1763. | 2036. |
| 26 NOV 2300 | 18 | 0.00 | 0.00 | 0.00 | 1664. | 1930. |
| 27 NOV 0000 | 19 | 0.00 | 0.00 | 0.00 | 1571. | 1763. |
| 27 NOV 0100 | 20 | 0.00 | 0.00 | 0.00 | 1483. | 1531. |
| 27 NOV 0200 | 21 | 0.00 | 0.00 | 0.00 | 1400. | 1295. |
| 27 NOV 0300 | 22 | 0.00 | 0.00 | 0.00 | 1322. | 1100. |
| 27 NOV 0400 | 23 | 0.00 | 0.00 | 0.00 | 1246. | 969. |
| 27 NOV 0500 | 24 | 0.00 | 0.00 | 0.00 | 1176. | 883. |
| 27 NOV 0600 | 25 | 0.00 | 0.00 | 0.00 | 1112. | 770. |
| 27 NOV 0700 | 26 | 0.00 | 0.00 | 0.00 | 1050. | 708. |
| 27 NOV 0800 | 27 | 0.00 | 0.00 | 0.00 | 991. | 659. |
| 27 NOV 0900 | 28 | 0.00 | 0.00 | 0.00 | 936. | 613. |
| 27 NOV 1000 | 29 | 0.00 | 0.00 | 0.00 | 884. | 580. |
| 27 NOV 1100 | 30 | 0.00 | 0.00 | 0.00 | 834. | 547. |
| 27 NOV 1200 | 31 | 0.00 | 0.00 | 0.00 | 788. | 516. |
| 27 NOV 1300 | 32 | 0.00 | 0.00 | 0.00 | 744. | 491. |
| 27 NOV 1400 | 33 | 0.00 | 0.00 | 0.00 | 703. | 464. |
| 27 NOV 1500 | 34 | 0.00 | 0.00 | 0.00 | 663. | 437. |
| 27 NOV 1600 | 35 | 0.00 | 0.00 | 0.00 | 626. | 419. |
| 27 NOV 1700 | 36 | 0.00 | 0.00 | 0.00 | 592. | 401. |
| 27 NOV 1800 | 37 | 0.00 | 0.00 | 0.00 | 559. | 389. |
| 27 NOV 1900 | 38 | 0.00 | 0.00 | 0.00 | 528. | 374. |
| 27 NOV 2000 | 39 | 0.00 | 0.00 | 0.00 | 498. | 364. |
| 27 NOV 2100 | 40 | 0.00 | 0.00 | 0.00 | 471. | 351. |
| 27 NOV 2200 | 41 | 0.00 | 0.00 | 0.00 | 444. | 342. |

TOTAL RAINFALL = 1.93, TOTAL LOSS = 1.01, TOTAL EXCESS = 0.93

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 40.00-HR |
|---|---|---|---|---|---|---|
| 2081. | 12.00 | (CFS) | 1974. | 1412. | 1019. | 1019. |
| | | (INCHES) | 0.237 | 0.678 | 0.815 | 0.815 |
| | | (AC-FT) | 979. | 2801. | 3368. | 3368. |

CUMULATIVE AREA = 77.50 SQ MI

STATION ELMIRA




(-) LIMITS OF OPTIMIZATION

```
                                             HEC-1 INPUT                                          PAGE  1

LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1          ID       NEWTOWN CREEK 10-28-81
  2          ID       UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3          IT      60 26OCT81    0500      83
  4          IO       1       2
  5          QU      25      65
  6          PG      EL    2.83
  7          PG      SP    4.59
  8          PG      AF
  9          PI     .00     .00     .00     .00     .10     .00     .00     .00     .00     .00
 10          PI     .00     .00     .10     .00     .00     .00     .00     .10     .00     .10
 11          PI     .20     .00     .10     .10     .10     .10     .10     .00     .00     .10
 12          PI     .00     .00     .00     .00     .00     .00     .00     .00     .10     .00
 13          PI     .00     .10     .20     .40     .50     .50     .30     .10     .10     .10
 14          PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 15          PG     HOR
 16          PI     .10     .00     .00     .00     .10     .00     .00     .00     .00     .00
 17          PI     .00     .00     .00     .00     .00     .00     .00     .10     .10     .10
 18          PI     .10     .20     .20     .00     .20     .10     .30     .00     .00     .00
 19          PI     .10     .00     .00     .00     .00     .00     .00     .00     .00     .00
 20          PI     .50     .10     .30     .50     .20     .20     .10     .10     .00     .00
 21          PI     .00     .00     .10     .00     .00     .00     .00     .00     .00     .00

 22          KK  ELMIRA
 23          QO      34      34      34      34      34      35      35      36      36      36
 24          QO      37      37      37      37      37      38      39      41      42      45
 25          QO      48      52      56      60      71     106     281     412     523     625
 26          QO     722     753     728     668     591     526     469     427     389     359
 27          QO     334     318     311     322     419     630    1164    1372    1479    1733
 28          QO    2182    2773    3038    3104    3069    2955    2748    2552    2357    2147
 29          QO    1945    1745    1562    1387    1256    1143    1049     978     920     866
 30          QO     822     776     739     703     665     636     613     591     572     545
 31          QO     510     475     448       0       0       0       0       0       0       0
 32          PT      EL      SP      AF     HOR
 33          PW     .46     .06     .47     .01
 34          PR      AF     HOR
 35          PW     .85     .15
 36          BA    77.5      0.
 37          BF     34.   1000.  1.0346
 38          UC    -10.    -12.
 39          LU     -.1    -.08
 40          ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 25 THROUGH 65)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.531 | | 42.69 | | | |
| COMPUTED HYDROGRAPH | 50546. | 1.011 | 1233. | 52.76 | 10.07 | 3072. | 53.00 |
| OBSERVED HYDROGRAPH | 50552. | 1.011 | 1233. | 51.87 | 9.18 | 3104. | 53.00 |
| DIFFERENCE | -6. | -0.000 | -0. | 0.89 | 0.89 | -32. | 0.00 |
| PERCENT DIFFERENCE | -0.01 | | | | 9.72 | -1.04 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 184. | AVERAGE ABSOLUTE ERROR | 137. |
| OBJECTIVE FUNCTION | 184. | AVERAGE PERCENT ABSOLUTE ERROR | 20.56 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 83)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.531 | | 42.69 | | | |
| COMPUTED HYDROGRAPH | 70019. | 1.400 | 844. | 57.80 | 15.11 | 3072. | 53.00 |
| OBSERVED HYDROGRAPH | 64557. | 1.291 | 778. | 55.60 | 12.91 | 3104. | 53.00 |
| DIFFERENCE | 5462. | 0.109 | 66. | 2.20 | 2.20 | -32. | 0.00 |
| PERCENT DIFFERENCE | 8.46 | | | | 17.07 | -1.04 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 197. | AVERAGE ABSOLUTE ERROR | 136. |
| OBJECTIVE FUNCTION | 221. | AVERAGE PERCENT ABSOLUTE ERROR | 27.83 |

UNIT HYDROGRAPH
92 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 84. | 318. | 654. | 1052. | 1478. | 1861. | 2148. | 2326. | 2340. | 2231. |
| 2099. | 1975. | 1858. | 1748. | 1645. | 1548. | 1456. | 1370. | 1289. | 1213. |
| 1142. | 1074. | 1011. | 951. | 895. | 842. | 792. | 745. | 701. | 660. |
| 621. | 584. | 550. | 517. | 487. | 458. | 431. | 405. | 381. | 359. |
| 338. | 318. | 299. | 281. | 265. | 249. | 234. | 220. | 207. | 195. |
| 184. | 173. | 163. | 153. | 144. | 135. | 127. | 120. | 113. | 106. |
| 100. | 94. | 88. | 83. | 78. | 74. | 69. | 65. | 61. | 58. |
| 54. | 51. | 48. | 45. | 43. | 40. | 38. | 35. | 33. | 31. |
| 30. | 28. | 26. | 25. | 23. | 22. | 20. | 19. | 18. | 17. |
| 16. | 15. | | | | | | | | |

HYDROGRAPH AT STATION ELMIRA

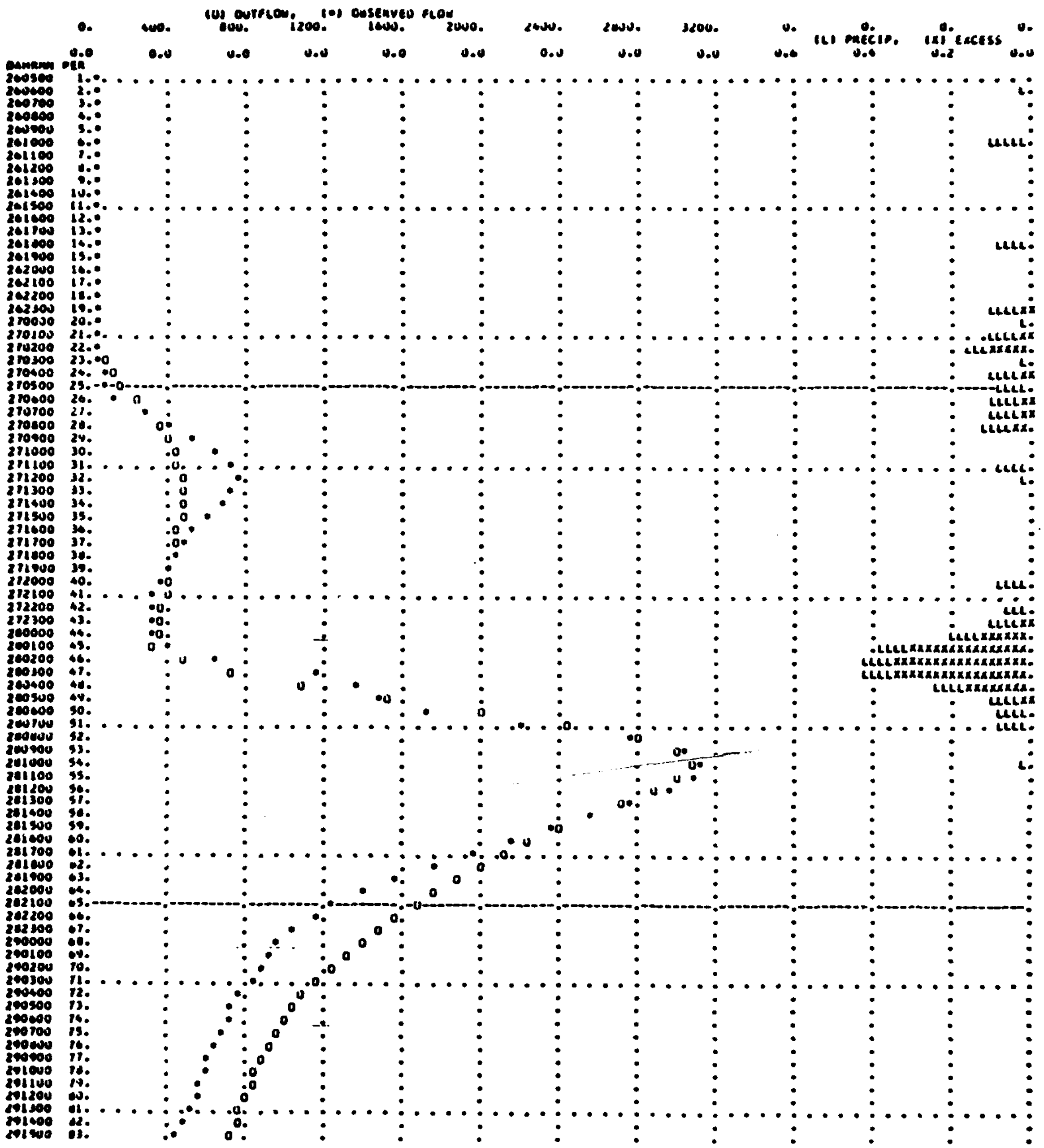
| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 26 OCT 0500 | 1 | 0.00 | 0.00 | 0.00 | 34. | 34. |
| 26 OCT 0600 | 2 | 0.01 | 0.01 | 0.00 | 33. | 34. |
| 26 OCT 0700 | 3 | 0.00 | 0.00 | 0.00 | 32. | 34. |
| 26 OCT 0800 | 4 | 0.00 | 0.00 | 0.00 | 31. | 34. |
| 26 OCT 0900 | 5 | 0.00 | 0.00 | 0.00 | 30. | 34. |
| 26 OCT 1000 | 6 | 0.09 | 0.09 | 0.00 | 29. | 35. |
| 26 OCT 1100 | 7 | 0.00 | 0.00 | 0.00 | 28. | 35. |
| 26 OCT 1200 | 8 | 0.00 | 0.00 | 0.00 | 27. | 36. |
| 26 OCT 1300 | 9 | 0.00 | 0.00 | 0.00 | 26. | 36. |
| 26 OCT 1400 | 10 | 0.00 | 0.00 | 0.00 | 25. | 36. |
| 26 OCT 1500 | 11 | 0.00 | 0.00 | 0.00 | 24. | 37. |
| 26 OCT 1600 | 12 | 0.00 | 0.00 | 0.00 | 23. | 37. |
| 26 OCT 1700 | 13 | 0.00 | 0.00 | 0.00 | 23. | 37. |
| 26 OCT 1800 | 14 | 0.08 | 0.08 | 0.00 | 22. | 37. |
| 26 OCT 1900 | 15 | 0.00 | 0.00 | 0.00 | 21. | 37. |
| 26 OCT 2000 | 16 | 0.00 | 0.00 | 0.00 | 21. | 38. |
| 26 OCT 2100 | 17 | 0.00 | 0.00 | 0.00 | 20. | 39. |
| 26 OCT 2200 | 18 | 0.00 | 0.00 | 0.00 | 20. | 41. |
| 26 OCT 2300 | 19 | 0.09 | 0.08 | 0.01 | 21. | 42. |
| 27 OCT 0000 | 20 | 0.01 | 0.01 | 0.00 | 24. | 45. |
| 27 OCT 0100 | 21 | 0.09 | 0.08 | 0.01 | 29. | 48. |
| 27 OCT 0200 | 22 | 0.17 | 0.08 | 0.09 | 46. | 52. |
| 27 OCT 0300 | 23 | 0.03 | 0.03 | 0.00 | 77. | 56. |
| 27 OCT 0400 | 24 | 0.10 | 0.08 | 0.03 | 121. | 60. |
| 27 OCT 0500 | 25 | 0.08 | 0.08 | 0.00 | 174. | 71. |
| 27 OCT 0600 | 26 | 0.10 | 0.08 | 0.03 | 233. | 106. |
| 27 OCT 0700 | 27 | 0.09 | 0.08 | 0.01 | 291. | 281. |
| 27 OCT 0800 | 28 | 0.12 | 0.08 | 0.04 | 346. | 412. |
| 27 OCT 0900 | 29 | 0.00 | 0.00 | 0.00 | 397. | 523. |
| 27 OCT 1000 | 30 | 0.00 | 0.00 | 0.00 | 434. | 625. |
| 27 OCT 1100 | 31 | 0.08 | 0.08 | 0.00 | 459. | 722. |
| 27 OCT 1200 | 32 | 0.01 | 0.01 | 0.00 | 475. | 753. |
| 27 OCT 1300 | 33 | 0.00 | 0.00 | 0.00 | 482. | 728. |
| 27 OCT 1400 | 34 | 0.00 | 0.00 | 0.00 | 480. | 668. |
| 27 OCT 1500 | 35 | 0.00 | 0.00 | 0.00 | 468. | 591. |
| 27 OCT 1600 | 36 | 0.00 | 0.00 | 0.00 | 452. | 526. |
| 27 OCT 1700 | 37 | 0.00 | 0.00 | 0.00 | 437. | 469. |
| 27 OCT 1800 | 38 | 0.00 | 0.00 | 0.00 | 422. | 427. |
| 27 OCT 1900 | 39 | 0.00 | 0.00 | 0.00 | 408. | 389. |
| 27 OCT 2000 | 40 | 0.08 | 0.08 | 0.00 | 394. | 359. |
| 27 OCT 2100 | 41 | 0.00 | 0.00 | 0.00 | 381. | 334. |
| 27 OCT 2200 | 42 | 0.07 | 0.07 | 0.00 | 366. | 318. |
| 27 OCT 2300 | 43 | 0.09 | 0.08 | 0.01 | 356. | 311. |
| 28 OCT 0000 | 44 | 0.20 | 0.08 | 0.12 | 344. | 322. |
| 28 OCT 0100 | 45 | 0.38 | 0.08 | 0.30 | 335. | 419. |
| 28 OCT 0200 | 46 | 0.41 | 0.08 | 0.34 | 465. | 630. |
| 28 OCT 0300 | 47 | 0.41 | 0.08 | 0.34 | 713. | 1164. |
| 28 OCT 0400 | 48 | 0.25 | 0.08 | 0.17 | 1083. | 1372. |
| 28 OCT 0500 | 49 | 0.09 | 0.08 | 0.01 | 1537. | 1479. |
| 28 OCT 0600 | 50 | 0.08 | 0.08 | 0.00 | 2015. | 1733. |
| 28 OCT 0700 | 51 | 0.08 | 0.08 | 0.00 | 2457. | 2182. |
| 28 OCT 0800 | 52 | 0.00 | 0.00 | 0.00 | 2804. | 2773. |
| 28 OCT 0900 | 53 | 0.00 | 0.00 | 0.00 | 3012. | 3038. |
| 28 OCT 1000 | 54 | 0.01 | 0.01 | 0.00 | 3072. | 3104. |
| 28 OCT 1100 | 55 | 0.00 | 0.00 | 0.00 | 3010. | 3069. |
| 28 OCT 1200 | 56 | 0.00 | 0.00 | 0.00 | 2873. | 2955. |
| 28 OCT 1300 | 57 | 0.00 | 0.00 | 0.00 | 2711. | 2748. |
| 28 OCT 1400 | 58 | 0.00 | 0.00 | 0.00 | 2551. | 2552. |
| 28 OCT 1500 | 59 | 0.00 | 0.00 | 0.00 | 2401. | 2357. |
| 28 OCT 1600 | 60 | 0.00 | 0.00 | 0.00 | 2259. | 2147. |
| 28 OCT 1700 | 61 | 0.00 | 0.00 | 0.00 | 2126. | 1945. |
| 28 OCT 1800 | 62 | 0.00 | 0.00 | 0.00 | 2000. | 1745. |
| 28 OCT 1900 | 63 | 0.00 | 0.00 | 0.00 | 1882. | 1562. |
| 28 OCT 2000 | 64 | 0.00 | 0.00 | 0.00 | 1771. | 1387. |
| 28 OCT 2100 | 65 | 0.00 | 0.00 | 0.00 | 1667. | 1256. |
| 28 OCT 2200 | 66 | 0.00 | 0.00 | 0.00 | 1568. | 1143. |
| 28 OCT 2300 | 67 | 0.00 | 0.00 | 0.00 | 1476. | 1049. |
| 29 OCT 0000 | 68 | 0.00 | 0.00 | 0.00 | 1388. | 978. |
| 29 OCT 0100 | 69 | 0.00 | 0.00 | 0.00 | 1307. | 920. |
| 29 OCT 0200 | 70 | 0.00 | 0.00 | 0.00 | 1229. | 866. |
| 29 OCT 0300 | 71 | 0.00 | 0.00 | 0.00 | 1157. | 822. |
| 29 OCT 0400 | 72 | 0.00 | 0.00 | 0.00 | 1089. | 776. |
| 29 OCT 0500 | 73 | 0.00 | 0.00 | 0.00 | 1024. | 739. |
| 29 OCT 0600 | 74 | 0.00 | 0.00 | 0.00 | 980. | 703. |
| 29 OCT 0700 | 75 | 0.00 | 0.00 | 0.00 | 947. | 665. |
| 29 OCT 0800 | 76 | 0.00 | 0.00 | 0.00 | 916. | 636. |
| 29 OCT 0900 | 77 | 0.00 | 0.00 | 0.00 | 885. | 613. |
| 29 OCT 1000 | 78 | 0.00 | 0.00 | 0.00 | 855. | 591. |
| 29 OCT 1100 | 79 | 0.00 | 0.00 | 0.00 | 827. | 572. |
| 29 OCT 1200 | 80 | 0.00 | 0.00 | 0.00 | 799. | 545. |
| 29 OCT 1300 | 81 | 0.00 | 0.00 | 0.00 | 772. | 510. |
| 29 OCT 1400 | 82 | 0.00 | 0.00 | 0.00 | 741. | 475. |
| 29 OCT 1500 | 83 | 0.00 | 0.00 | 0.00 | 722. | 448. |

TOTAL RAINFALL = 3.31, TOTAL LOSS = 1.78, TOTAL EXCESS = 1.53

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 82.00-HR |
|---|---|---|---|---|---|---|
| 3072. | 53.00 | (CFS) | 2093. | 2057. | 963. | 849. |
| | | (INCHES) | 0.347 | 0.987 | 1.387 | 1.392 |
| | | (AC-FT) | 1434. | 4079. | 5732. | 5755. |

CUMULATIVE AREA = 77.50 SQ MI

STATION ELMIRA




(-) LIMITS OF OPTIMIZATION

```
LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1             ID        OTSELIC RIVER     7-03-74
  2             ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3             IT      60 03MAR74    0400      60
  4             IO       1       2
  5             OU       1      25
  6             PG     CIN    1.31
  7             PG    LINC    3.60
  8             PG    DERU    3.17
  9             PG    PLYM
 10             PI     .05     .44     .91     .40     .05     .10     .00     .00     .00     .00
 11             PI     .00     .00     .01     .00     .01     .01     .01     .01     .00     .00

 12             KK  CINCIN
 13             QO      53      53      52      52      57      66     102     419    1130    1824
 14             QO    2549    3010    3110    3010    2675    2460    2265    2090    1964    1915
 15             QO    1873    1810    1705    1600    1516    1432    1348    1260    1180    1100
 16             QO    1024     947     872     808     748     700     656     622     595     570
 17             QO     546     525     504     486     473     461     449     437     428     419
 18             QO     410     401     395     389     383     380     374     372     366     360
 19             PT     CIN    LINC    DERU    PLYM
 20             PW     .18     .64    1.16     .02
 21             PR    PLYM
 22             PW    1.00
 23             BA    147.      0.
 24             BF     53.    400.  1.0163
 25             UC    -9.0    -13.
 26             LU     -1.     -1.
 27             ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 1 THROUGH 60)

| | SUM OF FLCWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.627 | | 4.80 | | | |
| CCMPUTED HYDROGRAPH | 59776. | 0.630 | 996. | 22.64 | 17.84 | 2970. | 13.00 |
| CBSERVED HYDROGRAPH | 59780. | 0.630 | 996. | 24.63 | 19.83 | 3110. | 12.00 |
| DIFFERENCE | -4. | -0.000 | -0. | -1.99 | -1.99 | -140. | 1.00 |
| PERCENT DIFFERENCE | -0.01 | | | | -10.03 | -4.50 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 197. | AVERAGE ABSOLUTE ERROR | 135. |
| OBJECTIVE FUNCTION | 190. | AVERAGE PERCENT ABSOLUTE ERROR | 41.43 |

UNIT HYDROGRAPH
81 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 136. | 512. | 1049. | 1682. | 2383. | 3104. | 3744. | 4237. | 4574. | 4729. |
| 4626. | 4343. | 4049. | 3774. | 3519. | 3280. | 3058. | 2851. | 2657. | 2477. |
| 2309. | 2153. | 2007. | 1871. | 1744. | 1626. | 1516. | 1413. | 1317. | 1228. |
| 1145. | 1067. | 995. | 927. | 865. | 806. | 751. | 700. | 653. | 609. |
| 567. | 529. | 493. | 460. | 429. | 400. | 372. | 347. | 324. | 302. |
| 281. | 262. | 244. | 228. | 212. | 198. | 185. | 172. | 160. | 150. |
| 139. | 130. | 121. | 113. | 105. | 98. | 92. | 85. | 80. | 74. |
| 69. | 64. | 60. | 56. | 52. | 49. | 45. | 42. | 39. | 37. |
| 34. | | | | | | | | | |

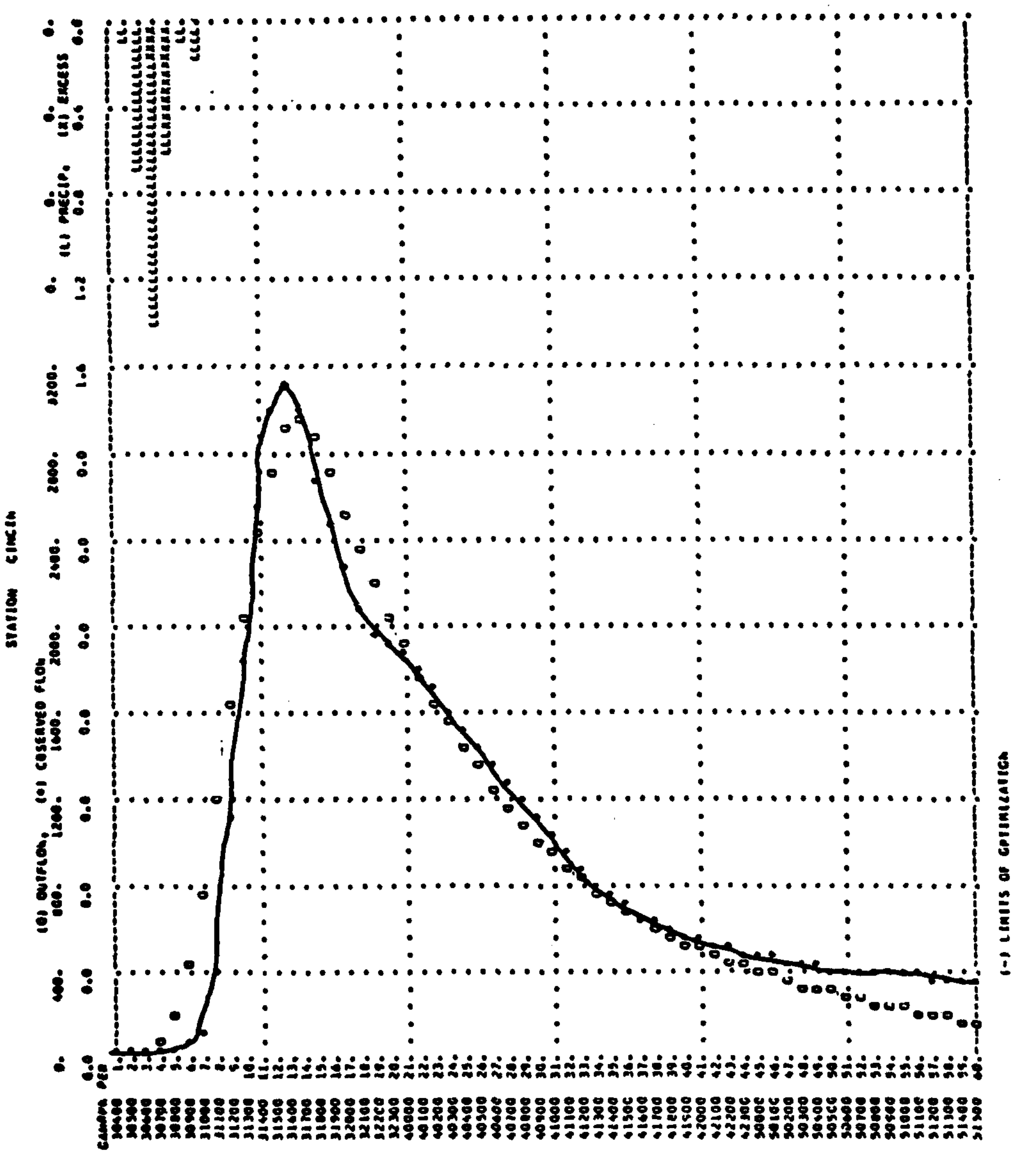
HYDROGRAPH AT STATION CINCIN

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 MAR 0400 | 1 | 0.00 | 0.00 | 0.00 | 53. | 53. | 4 MAR 1000 | 31 | 0.00 | 0.00 | 0.00 | 947. | 1024. |
| 3 MAR 0500 | 2 | 0.08 | 0.08 | 0.00 | 50. | 53. | 4 MAR 1100 | 32 | 0.00 | 0.00 | 0.00 | 882. | 947. |
| 3 MAR 0600 | 3 | 0.68 | 0.68 | 0.00 | 47. | 52. | 4 MAR 1200 | 33 | 0.00 | 0.00 | 0.00 | 823. | 872. |
| 3 MAR 0700 | 4 | 1.40 | 1.26 | 0.15 | 64. | 52. | 4 MAR 1300 | 34 | 0.00 | 0.00 | 0.00 | 767. | 808. |
| 3 MAR 0800 | 5 | 0.62 | 0.15 | 0.47 | 181. | 57. | 4 MAR 1400 | 35 | 0.00 | 0.00 | 0.00 | 722. | 748. |
| 3 MAR 0900 | 6 | 0.08 | 0.08 | 0.00 | 434. | 66. | 4 MAR 1500 | 36 | 0.00 | 0.00 | 0.00 | 681. | 700. |
| 3 MAR 1000 | 7 | 0.15 | 0.15 | 0.01 | 779. | 102. | 4 MAR 1600 | 37 | 0.00 | 0.00 | 0.00 | 642. | 656. |
| 3 MAR 1100 | 8 | 0.00 | 0.00 | 0.00 | 1182. | 419. | 4 MAR 1700 | 38 | 0.00 | 0.00 | 0.00 | 606. | 622. |
| 3 MAR 1200 | 9 | 0.00 | 0.00 | 0.00 | 1620. | 1130. | 4 MAR 1800 | 39 | 0.00 | 0.00 | 0.00 | 572. | 595. |
| 3 MAR 1300 | 10 | 0.00 | 0.00 | 0.00 | 2058. | 1824. | 4 MAR 1900 | 40 | 0.00 | 0.00 | 0.00 | 539. | 570. |
| 3 MAR 1400 | 11 | 0.00 | 0.00 | 0.00 | 2436. | 2549. | 4 MAR 2000 | 41 | 0.00 | 0.00 | 0.00 | 509. | 546. |
| 3 MAR 1500 | 12 | 0.00 | 0.00 | 0.00 | 2723. | 3010. | 4 MAR 2100 | 42 | 0.00 | 0.00 | 0.00 | 480. | 525. |
| 3 MAR 1600 | 13 | 0.00 | 0.00 | 0.00 | 2909. | 3110. | 4 MAR 2200 | 43 | 0.00 | 0.00 | 0.00 | 453. | 504. |
| 3 MAR 1700 | 14 | 0.02 | 0.02 | 0.00 | 2970. | 3010. | 4 MAR 2300 | 44 | 0.00 | 0.00 | 0.00 | 427. | 486. |
| 3 MAR 1800 | 15 | 0.00 | 0.00 | 0.00 | 2882. | 2675. | 5 MAR 0000 | 45 | 0.00 | 0.00 | 0.00 | 403. | 473. |
| 3 MAR 1900 | 16 | 0.02 | 0.02 | 0.00 | 2705. | 2460. | 5 MAR 0100 | 46 | 0.00 | 0.00 | 0.00 | 380. | 461. |
| 3 MAR 2000 | 17 | 0.02 | 0.02 | 0.00 | 2524. | 2265. | 5 MAR 0200 | 47 | 0.00 | 0.00 | 0.00 | 359. | 449. |
| 3 MAR 2100 | 18 | 0.02 | 0.02 | 0.00 | 2354. | 2090. | 5 MAR 0300 | 48 | 0.00 | 0.00 | 0.00 | 338. | 437. |
| 3 MAR 2200 | 19 | 0.02 | 0.02 | 0.00 | 2194. | 1964. | 5 MAR 0400 | 49 | 0.00 | 0.00 | 0.00 | 319. | 428. |
| 3 MAR 2300 | 20 | 0.00 | 0.00 | 0.00 | 2046. | 1915. | 5 MAR 0500 | 50 | 0.00 | 0.00 | 0.00 | 301. | 419. |
| 4 MAR 0000 | 21 | 0.00 | 0.00 | 0.00 | 1907. | 1873. | 5 MAR 0600 | 51 | 0.00 | 0.00 | 0.00 | 284. | 410. |
| 4 MAR 0100 | 22 | 0.00 | 0.00 | 0.00 | 1778. | 1810. | 5 MAR 0700 | 52 | 0.00 | 0.00 | 0.00 | 268. | 401. |
| 4 MAR 0200 | 23 | 0.00 | 0.00 | 0.00 | 1658. | 1705. | 5 MAR 0800 | 53 | 0.00 | 0.00 | 0.00 | 253. | 395. |
| 4 MAR 0300 | 24 | 0.00 | 0.00 | 0.00 | 1546. | 1600. | 5 MAR 0900 | 54 | 0.00 | 0.00 | 0.00 | 238. | 389. |
| 4 MAR 0400 | 25 | 0.00 | 0.00 | 0.00 | 1441. | 1516. | 5 MAR 1000 | 55 | 0.00 | 0.00 | 0.00 | 225. | 383. |
| 4 MAR 0500 | 26 | 0.00 | 0.00 | 0.00 | 1344. | 1432. | 5 MAR 1100 | 56 | 0.00 | 0.00 | 0.00 | 212. | 380. |
| 4 MAR 0600 | 27 | 0.00 | 0.00 | 0.00 | 1253. | 1348. | 5 MAR 1200 | 57 | 0.00 | 0.00 | 0.00 | 200. | 374. |
| 4 MAR 0700 | 28 | 0.00 | 0.00 | 0.00 | 1168. | 1260. | 5 MAR 1300 | 58 | 0.00 | 0.00 | 0.00 | 189. | 372. |
| 4 MAR 0800 | 29 | 0.00 | 0.00 | 0.00 | 1089. | 1180. | 5 MAR 1400 | 59 | 0.00 | 0.00 | 0.00 | 178. | 366. |
| 4 MAR 0900 | 30 | 0.00 | 0.00 | 0.00 | 1015. | 1100. | 5 MAR 1500 | 60 | 0.00 | 0.00 | 0.00 | 168. | 360. |

TOTAL RAINFALL = 3.09, TOTAL LOSS = 2.46, TOTAL EXCESS = 0.63

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 59.00-HR |
|---|---|---|---|---|---|---|
| 2970. | 13.00 | (CFS) | 2778. | 1903. | 1011. | 1011. |
| | | (INCHES) | 0.176 | 0.481 | 0.629 | 0.629 |
| | | (AC-FT) | 1378. | 3774. | 4931. | 4931. |

CUMULATIVE AREA = 147.00 SQ MI


STATION CINCIN
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP.
(X) EXCESS
(-) LIMITS OF OPTIMIZATION

```
                                      HEC-1 INPUT                                                 PAGE  1

LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.......10

  1         ID        UTSELIC RIVER     9-26-75
  2         ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3         IT      60 24SEP75    2400      90
  4         IO       1       2
  5         OU       5      55
  6         PG     CIN    4.86
  7         PG    LINC    4.97
  8         PG    DERU    4.40
  9         PG    WHPT
 10         PI     .10     .10     .00     .10     .00     .10     .20     .30     .30     .40
 11         PI     .10     .20     .00     .10     .00     .10     .30     .30     .00     .00
 12         PI     .00     .00     .00     .10     .10     .10     .10     .00     .00     .10
 13         PI     .30     .30     .20     .10     .20     .10     .10     .10     .00     .10
 14         PI     .00     .00     .10     .00     .00     .00     .00     .00     .00     .00

 15         KK  CINCIN
 16         QO     186     186     186     186     188     194     202     217     248     349
 17         QO     522     838    1128    1465    1732    1902    1999    2013    2083    2279
 18         QO    2444    2693    2830    2810    2756    2675    2549    2444    2356    2324
 19         QO    2308    2356    2612    2970    3486    3978    4480    4792    4974    5026
 20         QO    5000    4909    4805    4714    4626    4532    4458    4402    4302    4170
 21         QO    4002    3774    3541    3300    3060    2830    2639    2476    2316    2188
 22         QO    2076    1964    1878    1794    1721    1683    1605    1550    1500    1455
 23         QO    1410    1370    1330    1290    1250    1215    1182    1150    1119    1092
 24         QO    1060    1034    1007     980     957     935     914     894     878     862
 25         PT     CIN    LINC    DERU
 26         PW     .18     .66     .16
 27         PR    WHPT
 28         PW    1.00
 29         BA    147.      0.
 30         BF    186.    850.  1.0163
 31         UC    -7.0    -20.
 32         LU     -.9    -.05
 33         ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 5 THROUGH 55)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.281 | | 25.04 | | | |
| COMPUTED HYDROGRAPH | 143822. | 1.516 | 2820. | 36.90 | 11.86 | 4906. | 39.00 |
| OBSERVED HYDROGRAPH | 143817. | 1.516 | 2820. | 36.78 | 11.74 | 5026. | 39.00 |
| DIFFERENCE | 5. | 0.000 | 0. | 0.12 | 0.12 | -120. | 0.00 |
| PERCENT DIFFERENCE | 0.00 | | | | 1.03 | -2.39 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 300. | AVERAGE ABSOLUTE ERROR | 239. |
| OBJECTIVE FUNCTION | 286. | AVERAGE PERCENT ABSOLUTE ERROR | 14.08 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 90)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.281 | | 25.04 | | | |
| COMPUTED HYDROGRAPH | 205143. | 2.163 | 2279. | 46.33 | 21.29 | 4906. | 39.00 |
| OBSERVED HYDROGRAPH | 196165. | 2.068 | 2180. | 45.27 | 20.23 | 5026. | 39.00 |
| DIFFERENCE | 8978. | 0.095 | 100. | 1.05 | 1.05 | -120. | 0.00 |
| PERCENT DIFFERENCE | 4.58 | | | | 5.21 | -2.39 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 294. | AVERAGE ABSOLUTE ERROR | 236. |
| OBJECTIVE FUNCTION | 304. | AVERAGE PERCENT ABSOLUTE ERROR | 14.95 |

UNIT HYDROGRAPH
140 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 169. | 639. | 1322. | 2080. | 2732. | 3165. | 3229. | 3114. | 2995. | 2881. |
| 2771. | 2665. | 2563. | 2465. | 2371. | 2281. | 2193. | 2110. | 2029. | 1952. |
| 1877. | 1805. | 1737. | 1670. | 1606. | 1545. | 1486. | 1429. | 1375. | 1322. |
| 1272. | 1223. | 1177. | 1132. | 1088. | 1047. | 1007. | 968. | 931. | 896. |
| 862. | 829. | 797. | 767. | 737. | 709. | 682. | 656. | 631. | 607. |
| 584. | 561. | 540. | 519. | 500. | 481. | 462. | 445. | 428. | 411. |
| 396. | 380. | 366. | 352. | 338. | 326. | 313. | 301. | 290. | 279. |
| 268. | 258. | 248. | 238. | 229. | 221. | 212. | 204. | 196. | 189. |
| 182. | 175. | 168. | 162. | 155. | 149. | 144. | 138. | 133. | 128. |
| 123. | 118. | 114. | 109. | 105. | 101. | 97. | 94. | 90. | 87. |
| 83. | 80. | 77. | 74. | 71. | 69. | 66. | 63. | 61. | 59. |
| 56. | 54. | 52. | 50. | 48. | 46. | 45. | 43. | 41. | 40. |
| 38. | 37. | 35. | 34. | 33. | 31. | 30. | 29. | 28. | 27. |
| 26. | 25. | 24. | 23. | 22. | 21. | 21. | 20. | 19. | 18. |

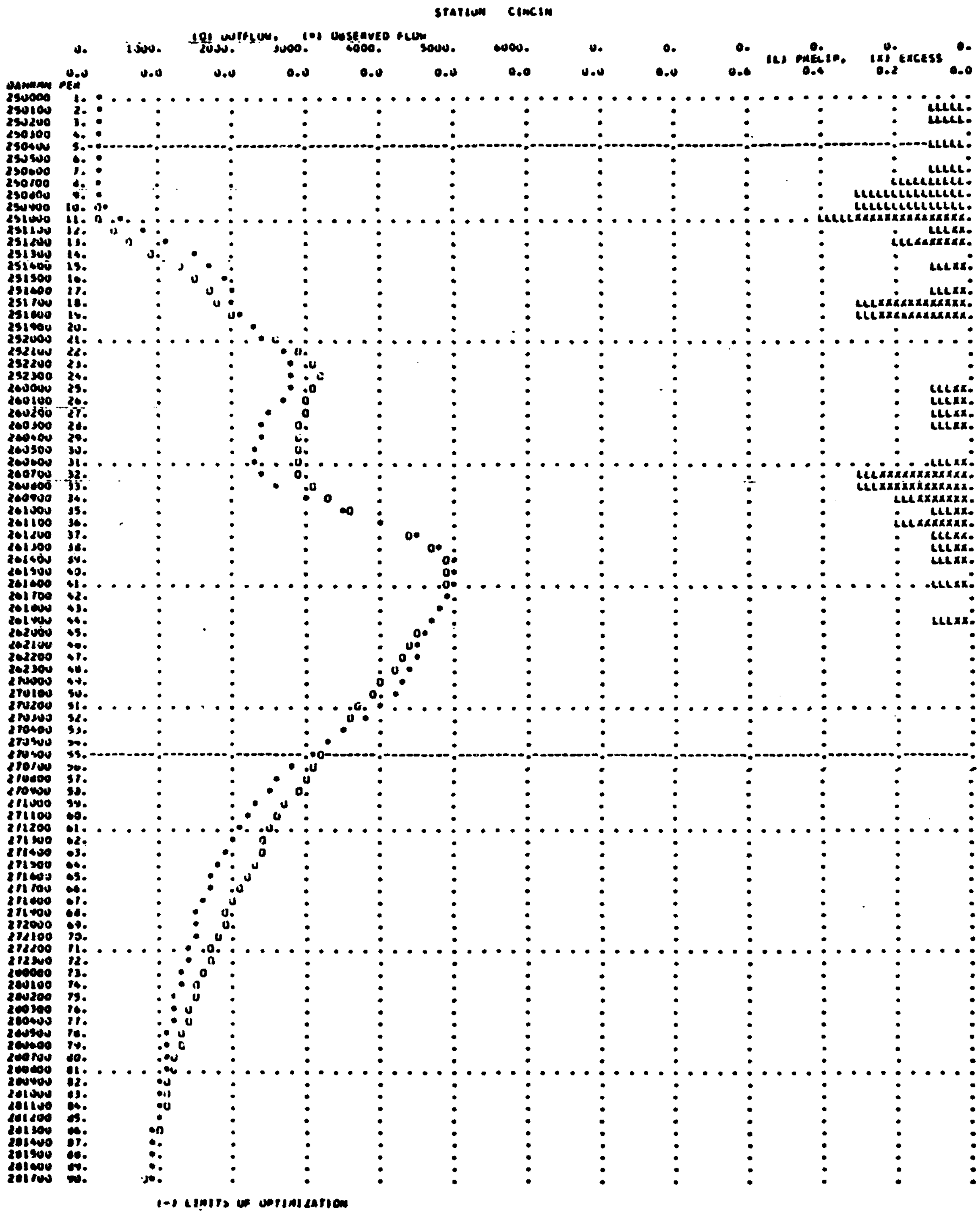
HYDROGRAPH AT STATION CINCIN

| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|
| 25 | SEP | 0000 | 1 | 0.00 | 0.00 | 0.00 | 186. | 186. |
| 25 | SEP | 0100 | 2 | 0.10 | 0.10 | 0.00 | 183. | 186. |
| 25 | SEP | 0200 | 3 | 0.10 | 0.10 | 0.00 | 180. | 186. |
| 25 | SEP | 0300 | 4 | 0.00 | 0.00 | 0.00 | 177. | 186. |
| 25 | SEP | 0400 | 5 | 0.10 | 0.10 | 0.00 | 174. | 188. |
| 25 | SEP | 0500 | 6 | 0.00 | 0.00 | 0.00 | 172. | 194. |
| 25 | SEP | 0600 | 7 | 0.10 | 0.10 | 0.00 | 169. | 202. |
| 25 | SEP | 0700 | 8 | 0.20 | 0.20 | 0.00 | 166. | 217. |
| 25 | SEP | 0800 | 9 | 0.30 | 0.30 | 0.00 | 163. | 248. |
| 25 | SEP | 0900 | 10 | 0.30 | 0.30 | 0.00 | 161. | 349. |
| 25 | SEP | 1000 | 11 | 0.40 | 0.10 | 0.30 | 209. | 522. |
| 25 | SEP | 1100 | 12 | 0.10 | 0.06 | 0.04 | 355. | 838. |
| 25 | SEP | 1200 | 13 | 0.20 | 0.06 | 0.14 | 602. | 1128. |
| 25 | SEP | 1300 | 14 | 0.00 | 0.00 | 0.00 | 924. | 1465. |
| 25 | SEP | 1400 | 15 | 0.10 | 0.06 | 0.04 | 1253. | 1732. |
| 25 | SEP | 1500 | 16 | 0.00 | 0.00 | 0.00 | 1530. | 1902. |
| 25 | SEP | 1600 | 17 | 0.10 | 0.06 | 0.04 | 1698. | 1999. |
| 25 | SEP | 1700 | 18 | 0.30 | 0.06 | 0.24 | 1815. | 2013. |
| 25 | SEP | 1800 | 19 | 0.30 | 0.06 | 0.24 | 1995. | 2083. |
| 25 | SEP | 1900 | 20 | 0.00 | 0.00 | 0.00 | 2266. | 2219. |
| 25 | SEP | 2000 | 21 | 0.00 | 0.00 | 0.00 | 2591. | 2444. |
| 25 | SEP | 2100 | 22 | 0.00 | 0.00 | 0.00 | 2892. | 2693. |
| 25 | SEP | 2200 | 23 | 0.00 | 0.00 | 0.00 | 3097. | 2830. |
| 25 | SEP | 2300 | 24 | 0.00 | 0.00 | 0.00 | 3158. | 2810. |
| 26 | SEP | 0000 | 25 | 0.10 | 0.06 | 0.04 | 3099. | 2756. |
| 26 | SEP | 0100 | 26 | 0.10 | 0.06 | 0.04 | 3012. | 2675. |
| 26 | SEP | 0200 | 27 | 0.10 | 0.06 | 0.04 | 2955. | 2549. |
| 26 | SEP | 0300 | 28 | 0.10 | 0.06 | 0.04 | 2934. | 2444. |
| 26 | SEP | 0400 | 29 | 0.00 | 0.00 | 0.00 | 2937. | 2356. |
| 26 | SEP | 0500 | 30 | 0.00 | 0.00 | 0.00 | 2942. | 2324. |
| 26 | SEP | 0600 | 31 | 0.10 | 0.06 | 0.04 | 2932. | 2308. |
| 26 | SEP | 0700 | 32 | 0.30 | 0.06 | 0.24 | 2944. | 2356. |
| 26 | SEP | 0800 | 33 | 0.30 | 0.06 | 0.24 | 3050. | 2612. |
| 26 | SEP | 0900 | 34 | 0.20 | 0.06 | 0.14 | 3291. | 2970. |
| 26 | SEP | 1000 | 35 | 0.10 | 0.06 | 0.04 | 3642. | 3486. |
| 26 | SEP | 1100 | 36 | 0.20 | 0.06 | 0.14 | 4047. | 3978. |
| 26 | SEP | 1200 | 37 | 0.10 | 0.06 | 0.04 | 4427. | 4480. |
| 26 | SEP | 1300 | 38 | 0.10 | 0.06 | 0.04 | 4701. | 4792. |
| 26 | SEP | 1400 | 39 | 0.10 | 0.06 | 0.04 | 4850. | 4974. |
| 26 | SEP | 1500 | 40 | 0.00 | 0.00 | 0.00 | 4906. | 5026. |
| 26 | SEP | 1600 | 41 | 0.10 | 0.06 | 0.04 | 4904. | 5000. |
| 26 | SEP | 1700 | 42 | 0.00 | 0.00 | 0.00 | 4853. | 4909. |
| 26 | SEP | 1800 | 43 | 0.00 | 0.00 | 0.00 | 4760. | 4805. |
| 26 | SEP | 1900 | 44 | 0.10 | 0.06 | 0.04 | 4650. | 4714. |
| 26 | SEP | 2000 | 45 | 0.00 | 0.00 | 0.00 | 4533. | 4626. |
| 26 | SEP | 2100 | 46 | 0.00 | 0.00 | 0.00 | 4413. | 4532. |
| 26 | SEP | 2200 | 47 | 0.00 | 0.00 | 0.00 | 4288. | 4458. |
| 26 | SEP | 2300 | 48 | 0.00 | 0.00 | 0.00 | 4157. | 4402. |
| 27 | SEP | 0000 | 49 | 0.00 | 0.00 | 0.00 | 4022. | 4302. |
| 27 | SEP | 0100 | 50 | 0.00 | 0.00 | 0.00 | 3878. | 4170. |
| 27 | SEP | 0200 | 51 | 0.00 | 0.00 | 0.00 | 3733. | 4002. |
| 27 | SEP | 0300 | 52 | 0.00 | 0.00 | 0.00 | 3592. | 3774. |
| 27 | SEP | 0400 | 53 | 0.00 | 0.00 | 0.00 | 3456. | 3541. |
| 27 | SEP | 0500 | 54 | 0.00 | 0.00 | 0.00 | 3326. | 3300. |
| 27 | SEP | 0600 | 55 | 0.00 | 0.00 | 0.00 | 3201. | 3060. |
| 27 | SEP | 0700 | 56 | 0.00 | 0.00 | 0.00 | 3080. | 2830. |
| 27 | SEP | 0800 | 57 | 0.00 | 0.00 | 0.00 | 2965. | 2639. |
| 27 | SEP | 0900 | 58 | 0.00 | 0.00 | 0.00 | 2853. | 2476. |
| 27 | SEP | 1000 | 59 | 0.00 | 0.00 | 0.00 | 2746. | 2316. |
| 27 | SEP | 1100 | 60 | 0.00 | 0.00 | 0.00 | 2642. | 2188. |
| 27 | SEP | 1200 | 61 | 0.00 | 0.00 | 0.00 | 2543. | 2076. |
| 27 | SEP | 1300 | 62 | 0.00 | 0.00 | 0.00 | 2448. | 1964. |
| 27 | SEP | 1400 | 63 | 0.00 | 0.00 | 0.00 | 2356. | 1878. |
| 27 | SEP | 1500 | 64 | 0.00 | 0.00 | 0.00 | 2267. | 1794. |
| 27 | SEP | 1600 | 65 | 0.00 | 0.00 | 0.00 | 2182. | 1721. |
| 27 | SEP | 1700 | 66 | 0.00 | 0.00 | 0.00 | 2100. | 1683. |
| 27 | SEP | 1800 | 67 | 0.00 | 0.00 | 0.00 | 2022. | 1605. |
| 27 | SEP | 1900 | 68 | 0.00 | 0.00 | 0.00 | 1946. | 1550. |
| 27 | SEP | 2000 | 69 | 0.00 | 0.00 | 0.00 | 1873. | 1580. |
| 27 | SEP | 2100 | 70 | 0.00 | 0.00 | 0.00 | 1803. | 1455. |
| 27 | SEP | 2200 | 71 | 0.00 | 0.00 | 0.00 | 1735. | 1410. |
| 27 | SEP | 2300 | 72 | 0.00 | 0.00 | 0.00 | 1670. | 1370. |
| 28 | SEP | 0000 | 73 | 0.00 | 0.00 | 0.00 | 1608. | 1330. |
| 28 | SEP | 0100 | 74 | 0.00 | 0.00 | 0.00 | 1548. | 1290. |
| 28 | SEP | 0200 | 75 | 0.00 | 0.00 | 0.00 | 1490. | 1250. |
| 28 | SEP | 0300 | 76 | 0.00 | 0.00 | 0.00 | 1434. | 1215. |
| 28 | SEP | 0400 | 77 | 0.00 | 0.00 | 0.00 | 1381. | 1182. |
| 28 | SEP | 0500 | 78 | 0.00 | 0.00 | 0.00 | 1329. | 1150. |
| 28 | SEP | 0600 | 79 | 0.00 | 0.00 | 0.00 | 1280. | 1119. |
| 28 | SEP | 0700 | 80 | 0.00 | 0.00 | 0.00 | 1232. | 1092. |
| 28 | SEP | 0800 | 81 | 0.00 | 0.00 | 0.00 | 1186. | 1060. |
| 28 | SEP | 0900 | 82 | 0.00 | 0.00 | 0.00 | 1142. | 1034. |
| 28 | SEP | 1000 | 83 | 0.00 | 0.00 | 0.00 | 1099. | 1007. |
| 28 | SEP | 1100 | 84 | 0.00 | 0.00 | 0.00 | 1058. | 980. |
| 28 | SEP | 1200 | 85 | 0.00 | 0.00 | 0.00 | 1019. | 957. |
| 28 | SEP | 1300 | 86 | 0.00 | 0.00 | 0.00 | 981. | 935. |
| 28 | SEP | 1400 | 87 | 0.00 | 0.00 | 0.00 | 945. | 914. |
| 28 | SEP | 1500 | 88 | 0.00 | 0.00 | 0.00 | 910. | 894. |
| 28 | SEP | 1600 | 89 | 0.00 | 0.00 | 0.00 | 876. | 878. |
| 28 | SEP | 1700 | 90 | 0.00 | 0.00 | 0.00 | 847. | 862. |

TOTAL RAINFALL = 4.36, TOTAL LOSS = 2.58, TOTAL EXCESS = 2.20

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 89.00-HR |
|---|---|---|---|---|---|---|
| 4906. | 39.00 | (CFS) | 4825. | 4072. | 2746. | 2299. |
| | | (INCHES) | 0.305 | 1.030 | 2.084 | 2.157 |
| | | (AC-FT) | 2392. | 8076. | 16340. | 16911. |

CUMULATIVE AREA = 147.00 SQ MI


STATION CINCIN
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS
(-) LIMITS OF OPTIMIZATION

```
                                           HEC-1 INPUT                                                PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1          ID        OTSELIC RIVER    10-09-76
   2          ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
   3          IT      60 07OCT76    1900      90
   4          IO       1       2
   5          QO      35       6
   6          PG     CIN     3.7
   7          PG    LINC    3.66
   8          PG    DERU    3.47
   9          PG   HUCOR
  10          PI     .10     .10     .00     .00     .10     .10     .10     .00     .00     .00
  11          PI     .00     .00     .00     .00     .10     .00     .00     .00     .00     .00
  12          PI     .10     .00     .00     .00     .00     .00     .00     .00     .00     .00
  13          PI     .00     .10     .10     .20     .00     .10     .20     .20     .20     .30
  14          PI     .30     .40     .20     .00     .10     .00     .00     .00     .00     .00

  15          KK  CINCIN
  16          QO     115     115     118     121     125     139     156     172     204     248
  17          QO     297     334     364     377     384     391     391     391     391     395
  18          QO     395     399     402     413     420     424     428     424     416     409
  19          QO     406     399     395     391     399     436     532     680     870    1146
  20          QO    1475    1996    2846    4000    5143    5806    5946    5848    5918    5750
  21          QO    5532    5428    5330    5358    5386    5386    5247    5036    4760    4431
  22          QO    4090    3790    3530    3292    3067    2854    2654    2478    2310    2166
  23          QO    2059    1961    1877    1793    1723    1653    1590    1534    1481    1436
  24          QO    1304    1336    1294    1252    1204    1168    1126    1090    1048    1019
  25          PT     CIN    LINC    DERU
  26          PW     .18     .66     .16
  27          PR   HUCOR
  28          PW    1.00
  29          BA    147.      0.
  30          BF    115.    750.  1.0163
  31          UC    -7.0    -18.
  32          LU     -.2     -.1
  33          ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 35 THROUGH 65)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.047 | | 37.18 | | | |
| COMPUTED HYDROGRAPH | 117938. | 1.243 | 3804. | 52.18 | 15.00 | 6350. | 48.00 |
| OBSERVED HYDROGRAPH | 118504. | 1.249 | 3823. | 52.53 | 15.36 | 5946. | 46.00 |
| DIFFERENCE | -566. | -0.006 | -18. | -0.35 | -0.35 | 404. | 2.00 |
| PERCENT DIFFERENCE | -0.48 | | | | -2.30 | 6.79 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 371. | AVERAGE ABSOLUTE ERROR | 322. |
| OBJECTIVE FUNCTION | 392. | AVERAGE PERCENT ABSOLUTE ERROR | 13.20 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 90)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 2.047 | | 37.18 | | | |
| COMPUTED HYDROGRAPH | 180040. | 1.898 | 2000. | 55.18 | 18.00 | 6350. | 48.00 |
| OBSERVED HYDROGRAPH | 170943. | 1.802 | 1899. | 56.14 | 18.97 | 5946. | 46.00 |
| DIFFERENCE | 9097. | 0.096 | 101. | -0.97 | -0.97 | 404. | 2.00 |
| PERCENT DIFFERENCE | 5.32 | | | | -5.11 | 6.79 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 243. | AVERAGE ABSOLUTE ERROR | 158. |
| OBJECTIVE FUNCTION | 344. | AVERAGE PERCENT ABSOLUTE ERROR | 11.46 |

UNIT HYDROGRAPH
117 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 154. | 582. | 1202. | 1937. | 2666. | 3251. | 3632. | 3716. | 3581. | 3416. |
| 3259. | 3109. | 2966. | 2829. | 2699. | 2574. | 2456. | 2342. | 2234. | 2132. |
| 2033. | 1940. | 1850. | 1765. | 1684. | 1606. | 1532. | 1461. | 1394. | 1330. |
| 1269. | 1210. | 1154. | 1101. | 1050. | 1002. | 956. | 912. | 870. | 830. |
| 792. | 755. | 720. | 687. | 655. | 625. | 596. | 569. | 543. | 518. |
| 494. | 471. | 449. | 429. | 409. | 390. | 372. | 355. | 339. | 323. |
| 308. | 294. | 280. | 267. | 255. | 243. | 232. | 221. | 211. | 202. |
| 192. | 183. | 175. | 167. | 159. | 152. | 145. | 138. | 132. | 126. |
| 120. | 114. | 109. | 104. | 99. | 95. | 90. | 86. | 82. | 78. |
| 75. | 71. | 68. | 65. | 62. | 59. | 56. | 54. | 51. | 49. |
| 47. | 45. | 42. | 41. | 39. | 37. | 35. | 34. | 32. | 31. |
| 29. | 28. | 27. | 25. | 24. | 23. | 22. | | | |

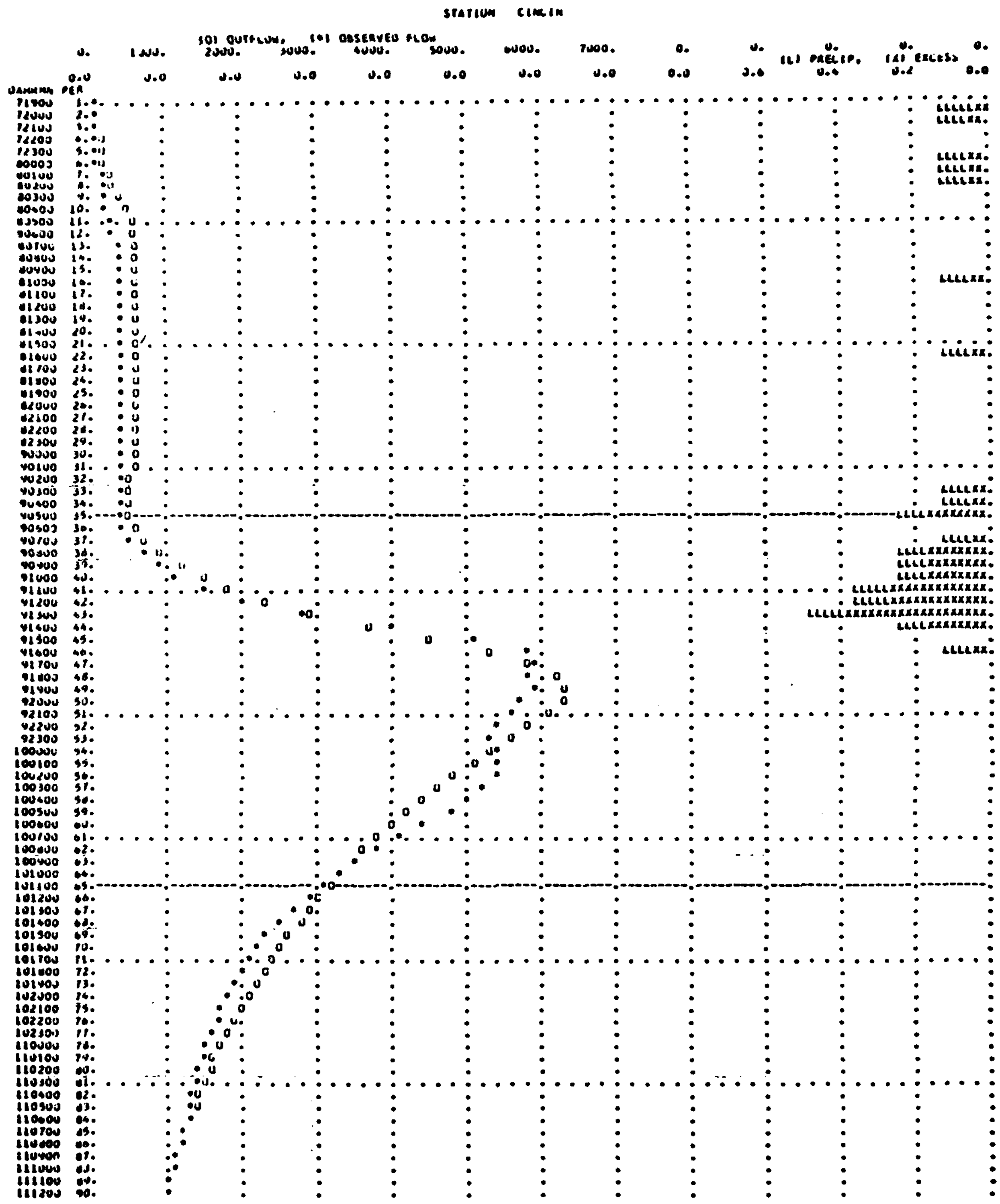
HYDROGRAPH AT STATION CINCIN

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 OCT 1900 | 1 | 0.00 | 0.00 | 0.00 | 115. | 115. | 9 OCT 1600 | 46 | 0.12 | 0.08 | 0.03 | 5259. | 5806. |
| 7 OCT 2000 | 2 | 0.12 | 0.10 | 0.02 | 114. | 115. | 9 OCT 1700 | 47 | 0.00 | 0.00 | 0.00 | 5848. | 5946. |
| 7 OCT 2100 | 3 | 0.12 | 0.08 | 0.03 | 128. | 118. | 9 OCT 1800 | 48 | 0.00 | 0.00 | 0.00 | 6217. | 5848. |
| 7 OCT 2200 | 4 | 0.00 | 0.00 | 0.00 | 152. | 121. | 9 OCT 1900 | 49 | 0.00 | 0.00 | 0.00 | 6350. | 5918. |
| 7 OCT 2300 | 5 | 0.00 | 0.00 | 0.00 | 186. | 125. | 9 OCT 2000 | 50 | 0.00 | 0.00 | 0.00 | 6274. | 5750. |
| 8 OCT 0000 | 6 | 0.12 | 0.08 | 0.03 | 228. | 139. | 9 OCT 2100 | 51 | 0.00 | 0.00 | 0.00 | 6064. | 5582. |
| 8 OCT 0100 | 7 | 0.12 | 0.08 | 0.03 | 282. | 156. | 9 OCT 2200 | 52 | 0.00 | 0.00 | 0.00 | 5809. | 5428. |
| 8 OCT 0200 | 8 | 0.12 | 0.08 | 0.03 | 349. | 172. | 9 OCT 2300 | 53 | 0.00 | 0.00 | 0.00 | 5552. | 5330. |
| 8 OCT 0300 | 9 | 0.00 | 0.00 | 0.00 | 423. | 204. | 10 OCT 0000 | 54 | 0.00 | 0.00 | 0.00 | 5299. | 5358. |
| 8 OCT 0400 | 10 | 0.00 | 0.00 | 0.00 | 493. | 248. | 10 OCT 0100 | 55 | 0.00 | 0.00 | 0.00 | 5056. | 5386. |
| 8 OCT 0500 | 11 | 0.00 | 0.00 | 0.00 | 553. | 297. | 10 OCT 0200 | 56 | 0.00 | 0.00 | 0.00 | 4825. | 5386. |
| 8 OCT 0600 | 12 | 0.00 | 0.00 | 0.00 | 601. | 334. | 10 OCT 0300 | 57 | 0.00 | 0.00 | 0.00 | 4604. | 5247. |
| 8 OCT 0700 | 13 | 0.00 | 0.00 | 0.00 | 627. | 364. | 10 OCT 0400 | 58 | 0.00 | 0.00 | 0.00 | 4393. | 5036. |
| 8 OCT 0800 | 14 | 0.00 | 0.00 | 0.00 | 629. | 377. | 10 OCT 0500 | 59 | 0.00 | 0.00 | 0.00 | 4192. | 4760. |
| 8 OCT 0900 | 15 | 0.00 | 0.00 | 0.00 | 619. | 384. | 10 OCT 0600 | 60 | 0.00 | 0.00 | 0.00 | 4000. | 4431. |
| 8 OCT 1000 | 16 | 0.12 | 0.08 | 0.03 | 609. | 391. | 10 OCT 0700 | 61 | 0.00 | 0.00 | 0.00 | 3817. | 4090. |
| 8 OCT 1100 | 17 | 0.00 | 0.00 | 0.00 | 599. | 391. | 10 OCT 0800 | 62 | 0.00 | 0.00 | 0.00 | 3643. | 3790. |
| 8 OCT 1200 | 18 | 0.00 | 0.00 | 0.00 | 590. | 391. | 10 OCT 0900 | 63 | 0.00 | 0.00 | 0.00 | 3476. | 3530. |
| 8 OCT 1300 | 19 | 0.00 | 0.00 | 0.00 | 585. | 391. | 10 OCT 1000 | 64 | 0.00 | 0.00 | 0.00 | 3317. | 3242. |
| 8 OCT 1400 | 20 | 0.00 | 0.00 | 0.00 | 588. | 395. | 10 OCT 1100 | 65 | 0.00 | 0.00 | 0.00 | 3165. | 3067. |
| 8 OCT 1500 | 21 | 0.00 | 0.00 | 0.00 | 588. | 395. | 10 OCT 1200 | 66 | 0.00 | 0.00 | 0.00 | 3021. | 2854. |
| 8 OCT 1600 | 22 | 0.12 | 0.08 | 0.03 | 587. | 399. | 10 OCT 1300 | 67 | 0.00 | 0.00 | 0.00 | 2883. | 2654. |
| 8 OCT 1700 | 23 | 0.00 | 0.00 | 0.00 | 586. | 402. | 10 OCT 1400 | 68 | 0.00 | 0.00 | 0.00 | 2751. | 2478. |
| 8 OCT 1800 | 24 | 0.00 | 0.00 | 0.00 | 585. | 413. | 10 OCT 1500 | 69 | 0.00 | 0.00 | 0.00 | 2626. | 2310. |
| 8 OCT 1900 | 25 | 0.00 | 0.00 | 0.00 | 587. | 420. | 10 OCT 1600 | 70 | 0.00 | 0.00 | 0.00 | 2506. | 2166. |
| 8 OCT 2000 | 26 | 0.00 | 0.00 | 0.00 | 590. | 424. | 10 OCT 1700 | 71 | 0.00 | 0.00 | 0.00 | 2391. | 2059. |
| 8 OCT 2100 | 27 | 0.00 | 0.00 | 0.00 | 590. | 428. | 10 OCT 1800 | 72 | 0.00 | 0.00 | 0.00 | 2282. | 1961. |
| 8 OCT 2200 | 28 | 0.00 | 0.00 | 0.00 | 583. | 424. | 10 OCT 1900 | 73 | 0.00 | 0.00 | 0.00 | 2178. | 1877. |
| 8 OCT 2300 | 29 | 0.00 | 0.00 | 0.00 | 573. | 416. | 10 OCT 2000 | 74 | 0.00 | 0.00 | 0.00 | 2079. | 1793. |
| 9 OCT 0000 | 30 | 0.00 | 0.00 | 0.00 | 564. | 409. | 10 OCT 2100 | 75 | 0.00 | 0.00 | 0.00 | 1984. | 1723. |
| 9 OCT 0100 | 31 | 0.00 | 0.00 | 0.00 | 555. | 406. | 10 OCT 2200 | 76 | 0.00 | 0.00 | 0.00 | 1894. | 1653. |
| 9 OCT 0200 | 32 | 0.00 | 0.00 | 0.00 | 546. | 399. | 10 OCT 2300 | 77 | 0.00 | 0.00 | 0.00 | 1808. | 1590. |
| 9 OCT 0300 | 33 | 0.12 | 0.08 | 0.03 | 538. | 395. | 11 OCT 0000 | 78 | 0.00 | 0.00 | 0.00 | 1725. | 1534. |
| 9 OCT 0400 | 34 | 0.12 | 0.08 | 0.03 | 529. | 391. | 11 OCT 0100 | 79 | 0.00 | 0.00 | 0.00 | 1647. | 1481. |
| 9 OCT 0500 | 35 | 0.24 | 0.08 | 0.15 | 524. | 399. | 11 OCT 0200 | 80 | 0.00 | 0.00 | 0.00 | 1572. | 1436. |
| 9 OCT 0600 | 36 | 0.00 | 0.00 | 0.00 | 617. | 436. | 11 OCT 0300 | 81 | 0.00 | 0.00 | 0.00 | 1500. | 1384. |
| 9 OCT 0700 | 37 | 0.12 | 0.08 | 0.03 | 749. | 532. | 11 OCT 0400 | 82 | 0.00 | 0.00 | 0.00 | 1432. | 1336. |
| 9 OCT 0800 | 38 | 0.24 | 0.08 | 0.15 | 927. | 680. | 11 OCT 0500 | 83 | 0.00 | 0.00 | 0.00 | 1367. | 1294. |
| 9 OCT 0900 | 39 | 0.24 | 0.08 | 0.15 | 1164. | 870. | 11 OCT 0600 | 84 | 0.00 | 0.00 | 0.00 | 1305. | 1252. |
| 9 OCT 1000 | 40 | 0.24 | 0.08 | 0.15 | 1462. | 1146. | 11 OCT 0700 | 85 | 0.00 | 0.00 | 0.00 | 1246. | 1204. |
| 9 OCT 1100 | 41 | 0.35 | 0.08 | 0.27 | 1840. | 1475. | 11 OCT 0800 | 86 | 0.00 | 0.00 | 0.00 | 1189. | 1168. |
| 9 OCT 1200 | 42 | 0.35 | 0.08 | 0.27 | 2323. | 1996. | 11 OCT 0900 | 87 | 0.00 | 0.00 | 0.00 | 1135. | 1126. |
| 9 OCT 1300 | 43 | 0.47 | 0.08 | 0.39 | 2944. | 2846. | 11 OCT 1000 | 88 | 0.00 | 0.00 | 0.00 | 1084. | 1090. |
| 9 OCT 1400 | 44 | 0.24 | 0.08 | 0.15 | 3711. | 4000. | 11 OCT 1100 | 89 | 0.00 | 0.00 | 0.00 | 1035. | 1048. |
| 9 OCT 1500 | 45 | 0.00 | 0.00 | 0.00 | 4920. | 5143. | 11 OCT 1200 | 90 | 0.00 | 0.00 | 0.00 | 988. | 1019. |

TOTAL RAINFALL = 3.65, TOTAL LOSS = 1.60, TOTAL EXCESS = 2.05

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 89.00-HR |
|---|---|---|---|---|---|---|
| 6350. | 48.00 | (CFS) | 6069. | 4638. | 2396. | 2317. |
| | | (INCHES) | 0.384 | 1.173 | 1.819 | 1.892 |
| | | (AC-FT) | 3009. | 9200. | 14260. | 14834. |

CUMULATIVE AREA = 147.00 SQ MI




(-) LIMITS OF OPTIMIZATION

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                                        HEC-1 INPUT                                                PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.......10

  1           ID        OTSELIC RIVER    10-17-77
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3           IT      60 16OCT77     1100       70
  4           IO       1       2
  5           OU       1      50
  6           PG     CIN    2.14
  7           PG    LINC    2.47
  8           PG    DERU    2.53
  9           PG   HUCUR
 10           PI     .10     .10     .10     .00     .00     .10     .00     .10     .10     .10
 11           PI     .00     .00     .10     .20     .00     .00     .20     .10     .10     .10
 12           PI     .10     .00     .10     .00     .10     .00     .00     .00     .00     .00
 13           PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 14           PI     .00     .00     .00     .00     .00     .00     .10     .00     .00     .00

 15           KK  CINCIN
 16           QU     460     468     480     512     585     675     757     815     855     890
 17           QU     931     969     991    1014    1084    1234    1436    1653    1856    2045
 18           QU    2230    2398    2550    2710    2846    2968    3058    3157    3238    3319
 19           QU    3364    3391    3391    3382    3346    3301    3256    3193    3130    3058
 20           QU    2986    2907    2822    2734    2646    2558    2470    2382    2302    2222
 21           QU    2136    2073    2010    1961    1905    1870    1835    1793    1758    1723
 22           QU    1681    1646    1611    1576    1541    1507    1481    1455    1422    1391
 23           PT     CIN    LINC    DERU
 24           PW     .18     .66     .16
 25           PR   HUCUR
 26           PW    1.00
 27           BA    147.      0.
 28           BF    460.   1400.  1.0163
 29           UC    -13.    -30.
 30           LU    -.03    -.03
 31           ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 1 THROUGH 50)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.645 | | 16.18 | | | |
| COMPUTED HYDROGRAPH | 106233. | 1.120 | 2125. | 31.22 | 15.05 | 3461. | 32.00 |
| OBSERVED HYDROGRAPH | 107020. | 1.128 | 2140. | 31.12 | 14.94 | 3391. | 31.00 |
| DIFFERENCE | -787. | -0.008 | -16. | 0.10 | 0.10 | 70. | 1.00 |
| PERCENT DIFFERENCE | -0.74 | | | | 0.69 | 2.06 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 89. | AVERAGE ABSOLUTE ERROR | 70. |
| OBJECTIVE FUNCTION | 82. | AVERAGE PERCENT ABSOLUTE ERROR | 5.31 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 70)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.645 | | 16.18 | | | |
| COMPUTED HYDROGRAPH | 141390. | 1.490 | 2020. | 38.30 | 22.12 | 3461. | 32.00 |
| OBSERVED HYDROGRAPH | 141395. | 1.491 | 2020. | 38.08 | 21.91 | 3391. | 31.00 |
| DIFFERENCE | -5. | -0.000 | -0. | 0.21 | 0.21 | 70. | 1.00 |
| PERCENT DIFFERENCE | -0.00 | | | | 0.97 | 2.06 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 91. | AVERAGE ABSOLUTE ERROR | 65. |
| OBJECTIVE FUNCTION | 77. | AVERAGE PERCENT ABSOLUTE ERROR | 4.64 |

UNIT HYDROGRAPH
150 END-OF-PERIOD ORDINATES
VOLUME = 0.99

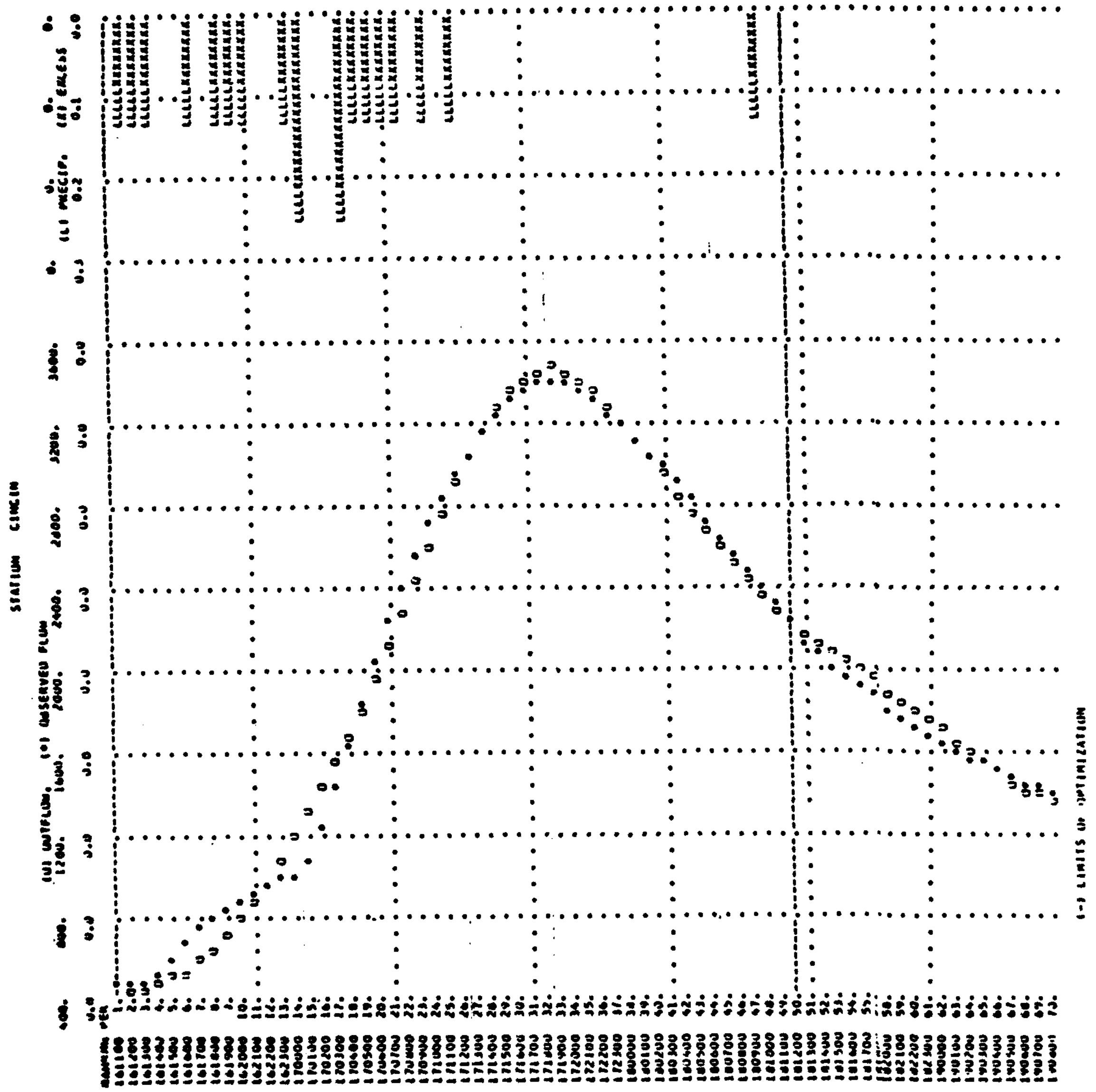
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 37. | 139. | 269. | 469. | 674. | 897. | 1137. | 1390. | 1639. | 1864. |
| 2060. | 2223. | 2354. | 2447. | 2496. | 2478. | 2407. | 2326. | 2249. | 2174. |
| 2102. | 2032. | 1964. | 1899. | 1835. | 1774. | 1715. | 1658. | 1603. | 1549. |
| 1498. | 1448. | 1400. | 1353. | 1308. | 1265. | 1222. | 1182. | 1142. | 1104. |
| 1068. | 1032. | 998. | 964. | 932. | 901. | 871. | 842. | 814. | 787. |
| 761. | 736. | 711. | 687. | 665. | 642. | 621. | 600. | 580. | 561. |
| 542. | 524. | 507. | 490. | 474. | 458. | 443. | 428. | 414. | 400. |
| 387. | 374. | 361. | 349. | 338. | 326. | 315. | 305. | 295. | 285. |
| 275. | 266. | 257. | 249. | 241. | 233. | 225. | 217. | 210. | 203. |
| 196. | 190. | 183. | 177. | 171. | 166. | 160. | 155. | 150. | 145. |
| 140. | 135. | 131. | 126. | 122. | 118. | 114. | 110. | 107. | 103. |
| 100. | 96. | 93. | 90. | 87. | 84. | 81. | 79. | 76. | 74. |
| 71. | 69. | 66. | 64. | 62. | 60. | 58. | 56. | 54. | 52. |
| 51. | 49. | 47. | 46. | 44. | 43. | 41. | 40. | 39. | 37. |
| 36. | 35. | 34. | 33. | 32. | 30. | 29. | 28. | 28. | 27. |

HYDROGRAPH AT STATION CINCIN

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|
| 16 OCT 1100 | 1 | 0.00 | 0.00 | 0.00 | 460. | 460. |
| 16 OCT 1200 | 2 | 0.13 | 0.05 | 0.08 | 455. | 468. |
| 16 OCT 1300 | 3 | 0.13 | 0.05 | 0.08 | 459. | 480. |
| 16 OCT 1400 | 4 | 0.13 | 0.05 | 0.08 | 475. | 512. |
| 16 OCT 1500 | 5 | 0.00 | 0.00 | 0.00 | 502. | 585. |
| 16 OCT 1600 | 6 | 0.00 | 0.00 | 0.00 | 538. | 675. |
| 16 OCT 1700 | 7 | 0.13 | 0.05 | 0.08 | 583. | 757. |
| 16 OCT 1800 | 8 | 0.00 | 0.00 | 0.00 | 638. | 815. |
| 16 OCT 1900 | 9 | 0.13 | 0.05 | 0.08 | 704. | 855. |
| 16 OCT 2000 | 10 | 0.13 | 0.05 | 0.08 | 783. | 890. |
| 16 OCT 2100 | 11 | 0.13 | 0.05 | 0.08 | 876. | 931. |
| 16 OCT 2200 | 12 | 0.00 | 0.00 | 0.00 | 977. | 969. |
| 16 OCT 2300 | 13 | 0.00 | 0.00 | 0.00 | 1082. | 991. |
| 17 OCT 0000 | 14 | 0.13 | 0.05 | 0.08 | 1189. | 1014. |
| 17 OCT 0100 | 15 | 0.25 | 0.05 | 0.21 | 1305. | 1084. |
| 17 OCT 0200 | 16 | 0.00 | 0.00 | 0.00 | 1433. | 1234. |
| 17 OCT 0300 | 17 | 0.00 | 0.00 | 0.00 | 1560. | 1436. |
| 17 OCT 0400 | 18 | 0.25 | 0.05 | 0.21 | 1687. | 1653. |
| 17 OCT 0500 | 19 | 0.13 | 0.05 | 0.08 | 1819. | 1856. |
| 17 OCT 0600 | 20 | 0.13 | 0.05 | 0.08 | 1960. | 2045. |
| 17 OCT 0700 | 21 | 0.13 | 0.05 | 0.08 | 2113. | 2230. |
| 17 OCT 0800 | 22 | 0.13 | 0.05 | 0.08 | 2275. | 2398. |
| 17 OCT 0900 | 23 | 0.00 | 0.00 | 0.00 | 2438. | 2550. |
| 17 OCT 1000 | 24 | 0.13 | 0.05 | 0.08 | 2599. | 2710. |
| 17 OCT 1100 | 25 | 0.00 | 0.00 | 0.00 | 2753. | 2846. |
| 17 OCT 1200 | 26 | 0.13 | 0.05 | 0.08 | 2900. | 2968. |
| 17 OCT 1300 | 27 | 0.00 | 0.00 | 0.00 | 3040. | 3058. |
| 17 OCT 1400 | 28 | 0.00 | 0.00 | 0.00 | 3169. | 3157. |
| 17 OCT 1500 | 29 | 0.00 | 0.00 | 0.00 | 3277. | 3238. |
| 17 OCT 1600 | 30 | 0.00 | 0.00 | 0.00 | 3358. | 3319. |
| 17 OCT 1700 | 31 | 0.00 | 0.00 | 0.00 | 3414. | 3364. |
| 17 OCT 1800 | 32 | 0.00 | 0.00 | 0.00 | 3450. | 3391. |
| 17 OCT 1900 | 33 | 0.00 | 0.00 | 0.00 | 3461. | 3391. |
| 17 OCT 2000 | 34 | 0.00 | 0.00 | 0.00 | 3445. | 3362. |
| 17 OCT 2100 | 35 | 0.00 | 0.00 | 0.00 | 3408. | 3346. |
| 17 OCT 2200 | 36 | 0.00 | 0.00 | 0.00 | 3354. | 3301. |
| 17 OCT 2300 | 37 | 0.00 | 0.00 | 0.00 | 3286. | 3256. |
| 18 OCT 0000 | 38 | 0.00 | 0.00 | 0.00 | 3210. | 3193. |
| 18 OCT 0100 | 39 | 0.00 | 0.00 | 0.00 | 3127. | 3130. |
| 18 OCT 0200 | 40 | 0.00 | 0.00 | 0.00 | 3038. | 3058. |
| 18 OCT 0300 | 41 | 0.00 | 0.00 | 0.00 | 2947. | 2986. |
| 18 OCT 0400 | 42 | 0.00 | 0.00 | 0.00 | 2854. | 2902. |
| 18 OCT 0500 | 43 | 0.00 | 0.00 | 0.00 | 2763. | 2822. |
| 18 OCT 0600 | 44 | 0.00 | 0.00 | 0.00 | 2675. | 2734. |
| 18 OCT 0700 | 45 | 0.00 | 0.00 | 0.00 | 2590. | 2646. |
| 18 OCT 0800 | 46 | 0.00 | 0.00 | 0.00 | 2507. | 2558. |
| 18 OCT 0900 | 47 | 0.00 | 0.00 | 0.00 | 2428. | 2470. |
| 18 OCT 1000 | 48 | 0.13 | 0.05 | 0.08 | 2354. | 2382. |
| 18 OCT 1100 | 49 | 0.00 | 0.00 | 0.00 | 2288. | 2302. |
| 18 OCT 1200 | 50 | 0.00 | 0.00 | 0.00 | 2228. | 2222. |
| 18 OCT 1300 | 51 | 0.00 | 0.00 | 0.00 | 2173. | 2136. |
| 18 OCT 1400 | 52 | 0.00 | 0.00 | 0.00 | 2122. | 2073. |
| 18 OCT 1500 | 53 | 0.00 | 0.00 | 0.00 | 2075. | 2010. |
| 18 OCT 1600 | 54 | 0.00 | 0.00 | 0.00 | 2031. | 1961. |
| 18 OCT 1700 | 55 | 0.00 | 0.00 | 0.00 | 1991. | 1905. |
| 18 OCT 1800 | 56 | 0.00 | 0.00 | 0.00 | 1952. | 1870. |
| 18 OCT 1900 | 57 | 0.00 | 0.00 | 0.00 | 1914. | 1835. |
| 18 OCT 2000 | 58 | 0.00 | 0.00 | 0.00 | 1874. | 1793. |
| 18 OCT 2100 | 59 | 0.00 | 0.00 | 0.00 | 1834. | 1756. |
| 18 OCT 2200 | 60 | 0.00 | 0.00 | 0.00 | 1793. | 1723. |
| 18 OCT 2300 | 61 | 0.00 | 0.00 | 0.00 | 1750. | 1681. |
| 19 OCT 0000 | 62 | 0.00 | 0.00 | 0.00 | 1706. | 1646. |
| 19 OCT 0100 | 63 | 0.00 | 0.00 | 0.00 | 1657. | 1611. |
| 19 OCT 0200 | 64 | 0.00 | 0.00 | 0.00 | 1606. | 1576. |
| 19 OCT 0300 | 65 | 0.00 | 0.00 | 0.00 | 1555. | 1541. |
| 19 OCT 0400 | 66 | 0.00 | 0.00 | 0.00 | 1506. | 1507. |
| 19 OCT 0500 | 67 | 0.00 | 0.00 | 0.00 | 1459. | 1481. |
| 19 OCT 0600 | 68 | 0.00 | 0.00 | 0.00 | 1413. | 1455. |
| 19 OCT 0700 | 69 | 0.00 | 0.00 | 0.00 | 1384. | 1422. |
| 19 OCT 0800 | 70 | 0.00 | 0.00 | 0.00 | 1362. | 1391. |

TOTAL RAINFALL = 2.42, TOTAL LOSS = 0.78, TOTAL EXCESS = 1.64

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 69.00-HR |
|---|---|---|---|---|---|---|
| 3461. | 32.00 | (CFS) | 3422. | 3044. | 2036. | 2036. |
| | | (INCHES) | 0.216 | 0.770 | 1.481 | 1.481 |
| | | (AC-FT) | 1697. | 6038. | 11610. | 11610. |



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                                              HEC-1 INPUT                                                    PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1          ID        OTSELIC RIVER     4-05-78
   2          ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
   3          IT       60 04APR78    1300      52
   4          IO        1       2
   5          OU        5      35
   6          PG      CIN    1.26
   7          PG     DERU     .92
   8          PG    HUCOR
   9          PI      .00     .00     .00     .00     .10     .10     .10     .20     .10     .00
  10          PI      .10     .10     .00     .00     .10     .00     .00     .00     .00     .00

  11          KK   CINCIN
  12          QO      926     920     926     931     947     986    1036    1144    1324    1569
  13          QO     1800    2246    2590    2798    2918    2997    2968    2934    2894    2918
  14          QO     2986    3040    3067    3040    2959    2870    2782    2678    2566    2470
  15          QO     2358    2270    2174    2101    2031    1961    1898    1842    1786    1757
  16          QO     1688    1639    1597    1555    1520    1494    1462    1436    1409    1397
  17          QO     1384    1378       0       0       0       0       0       0       0       0
  18          PT      CIN    DERU
  19          PW      .46     .54
  20          PK    HUCOR
  21          PW     1.00
  22          BA     147.      0.
  23          BF     926.   1600.  1.0163
  24          UC      -7.    -21.
  25          LU      -1.    -.05
  26          ZZ
```

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         10.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

         ID       OTSELIC RIVER    4-05-78
         ID       UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
         IT      60 04APR78    1300      52
         IO       1       2
         OU       5      35
         PG     CIN    1.26
         PG    DERU     .92
         PG   HUCUR
         PI     .00     .00     .00     .00     .10     .10     .10     .20     .10     .00
         PI     .10     .10     .00     .00     .10     .00     .00     .00     .00     .00

         KK  CINCIN
         QO     926     920     926     931     947     986    1036    1144    1324    1569
         QO    1800    2246    2590    2798    2918    2997    2968    2934    2894    2918
         QO    2986    3040    3067    3040    2959    2870    2782    2678    2566    2470
         QO    2358    2270    2174    2101    2031    1961    1898    1842    1786    1737
         QO    1688    1639    1597    1555    1520    1494    1462    1436    1409    1397
         QO    1384    1378       0       0       0       0       0       0       0       0
         PT     CIN    DERU
         PW     .46     .54
         PR   HUCUR
         PW    1.00
         BA    147.      0.
         BF    926.   1600.  1.0163
         UC     -7.    -21.
         LU     -1.    -.05
         ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 5 THROUGH 35)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.963 | | 10.19 | | | |
| COMPUTED HYDROGRAPH | 73470. | 0.774 | 2370. | 21.30 | 11.10 | 3265. | 18.00 |
| OBSERVED HYDROGRAPH | 73461. | 0.774 | 2370. | 21.28 | 11.08 | 3067. | 22.00 |
| DIFFERENCE | 9. | 0.000 | 0. | 0.02 | 0.02 | 198. | -4.00 |
| PERCENT DIFFERENCE | 0.01 | | | | 0.20 | 6.45 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 147. | AVERAGE ABSOLUTE ERROR | 114. |
| OBJECTIVE FUNCTION | 152. | AVERAGE PERCENT ABSOLUTE ERROR | 5.31 |

### STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 52)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 0.963 | | 10.19 | | | |
| COMPUTED HYDROGRAPH | 104504. | 1.102 | 2010. | 26.46 | 16.27 | 3265. | 18.00 |
| OBSERVED HYDROGRAPH | 104347. | 1.100 | 2007. | 26.38 | 16.19 | 3067. | 22.00 |
| DIFFERENCE | 157. | 0.002 | 3. | 0.08 | 0.08 | 198. | -4.00 |
| PERCENT DIFFERENCE | 0.15 | | | | 0.47 | 6.45 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 114. | AVERAGE ABSOLUTE ERROR | 73. |
| OBJECTIVE FUNCTION | 128. | AVERAGE PERCENT ABSOLUTE ERROR | 3.79 |

UNIT HYDROGRAPH
144 END-OF-PERIOD ORDINATES

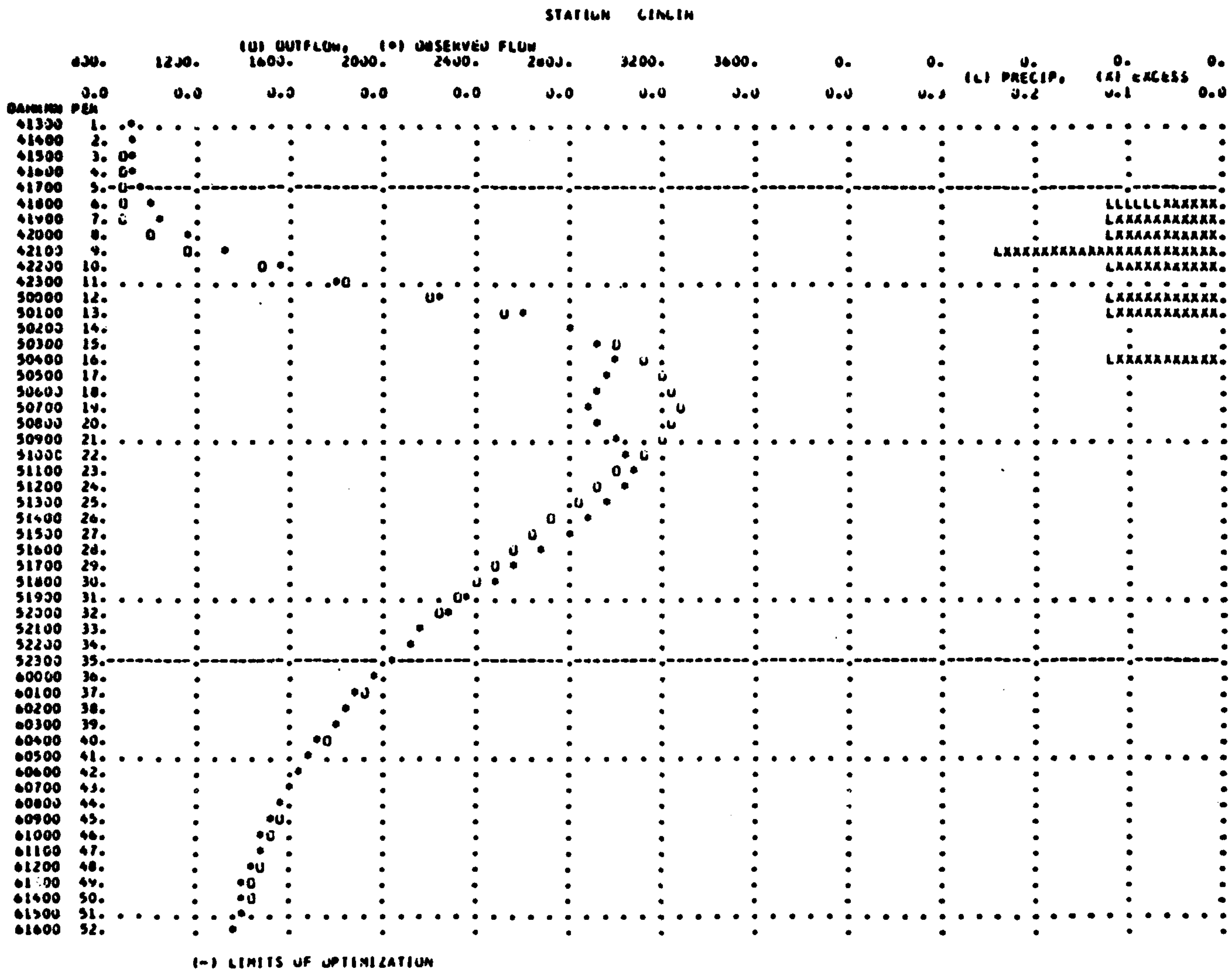
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 156. | 592. | 1225. | 1940. | 2575. | 3004. | 3131. | 3044. | 2931. | 2823. |
| 2716. | 2617. | 2521. | 2427. | 2337. | 2251. | 2168. | 2087. | 2010. | 1936. |
| 1864. | 1795. | 1729. | 1665. | 1603. | 1544. | 1487. | 1432. | 1379. | 1328. |
| 1279. | 1231. | 1186. | 1142. | 1100. | 1059. | 1020. | 982. | 946. | 911. |
| 877. | 844. | 813. | 783. | 754. | 726. | 699. | 673. | 649. | 625. |
| 601. | 579. | 558. | 537. | 517. | 498. | 480. | 462. | 445. | 428. |
| 412. | 397. | 382. | 368. | 355. | 342. | 329. | 317. | 305. | 294. |
| 283. | 272. | 262. | 253. | 243. | 234. | 226. | 217. | 209. | 201. |
| 194. | 187. | 180. | 173. | 167. | 161. | 155. | 149. | 143. | 138. |
| 133. | 128. | 123. | 119. | 114. | 110. | 106. | 102. | 98. | 95. |
| 91. | 88. | 85. | 81. | 78. | 76. | 73. | 70. | 67. | 65. |
| 63. | 60. | 58. | 56. | 54. | 52. | 50. | 48. | 46. | 45. |
| 43. | 41. | 40. | 38. | 37. | 36. | 34. | 33. | 32. | 31. |
| 29. | 28. | 27. | 26. | 25. | 24. | 23. | 23. | 22. | 21. |
| 20. | 19. | 19. | 18. | | | | | | |

HYDROGRAPH AT STATION CINCIN

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 APR 1300 | 1 | 0.00 | 0.00 | 0.00 | 926. | 926. | 5 APR 1500 | 27 | 0.00 | 0.00 | 0.00 | 2645. | 2762. |
| 4 APR 1400 | 2 | 0.00 | 0.00 | 0.00 | 911. | 920. | 5 APR 1600 | 28 | 0.00 | 0.00 | 0.00 | 2560. | 2678. |
| 4 APR 1500 | 3 | 0.00 | 0.00 | 0.00 | 897. | 926. | 5 APR 1700 | 29 | 0.00 | 0.00 | 0.00 | 2478. | 2566. |
| 4 APR 1600 | 4 | 0.00 | 0.00 | 0.00 | 882. | 931. | 5 APR 1800 | 30 | 0.00 | 0.00 | 0.00 | 2398. | 2470. |
| 4 APR 1700 | 5 | 0.00 | 0.00 | 0.00 | 868. | 947. | 5 APR 1900 | 31 | 0.00 | 0.00 | 0.00 | 2322. | 2358. |
| 4 APR 1800 | 6 | 0.12 | 0.06 | 0.06 | 864. | 966. | 5 APR 2000 | 32 | 0.00 | 0.00 | 0.00 | 2248. | 2270. |
| 4 APR 1900 | 7 | 0.12 | 0.01 | 0.11 | 895. | 1036. | 5 APR 2100 | 33 | 0.00 | 0.00 | 0.00 | 2176. | 2174. |
| 4 APR 2000 | 8 | 0.12 | 0.01 | 0.11 | 987. | 1144. | 5 APR 2200 | 34 | 0.00 | 0.00 | 0.00 | 2107. | 2101. |
| 4 APR 2100 | 9 | 0.24 | 0.01 | 0.23 | 1174. | 1324. | 5 APR 2300 | 35 | 0.00 | 0.00 | 0.00 | 2041. | 2031. |
| 4 APR 2200 | 10 | 0.12 | 0.01 | 0.11 | 1470. | 1569. | 6 APR 0000 | 36 | 0.00 | 0.00 | 0.00 | 1977. | 1961. |
| 4 APR 2300 | 11 | 0.00 | 0.00 | 0.00 | 1829. | 1800. | 6 APR 0100 | 37 | 0.00 | 0.00 | 0.00 | 1914. | 1898. |
| 5 APR 0000 | 12 | 0.12 | 0.01 | 0.11 | 2196. | 2246. | 6 APR 0200 | 38 | 0.00 | 0.00 | 0.00 | 1854. | 1842. |
| 5 APR 0100 | 13 | 0.12 | 0.01 | 0.11 | 2533. | 2590. | 6 APR 0300 | 39 | 0.00 | 0.00 | 0.00 | 1796. | 1786. |
| 5 APR 0200 | 14 | 0.00 | 0.00 | 0.00 | 2807. | 2798. | 6 APR 0400 | 40 | 0.00 | 0.00 | 0.00 | 1740. | 1737. |
| 5 APR 0300 | 15 | 0.00 | 0.00 | 0.00 | 2993. | 2918. | 6 APR 0500 | 41 | 0.00 | 0.00 | 0.00 | 1686. | 1688. |
| 5 APR 0400 | 16 | 0.12 | 0.01 | 0.11 | 3112. | 2997. | 6 APR 0600 | 42 | 0.00 | 0.00 | 0.00 | 1634. | 1639. |
| 5 APR 0500 | 17 | 0.00 | 0.00 | 0.00 | 3202. | 2968. | 6 APR 0700 | 43 | 0.00 | 0.00 | 0.00 | 1592. | 1597. |
| 5 APR 0600 | 18 | 0.00 | 0.00 | 0.00 | 3256. | 2934. | 6 APR 0800 | 44 | 0.00 | 0.00 | 0.00 | 1566. | 1555. |
| 5 APR 0700 | 19 | 0.00 | 0.00 | 0.00 | 3265. | 2894. | 6 APR 0900 | 45 | 0.00 | 0.00 | 0.00 | 1541. | 1520. |
| 5 APR 0800 | 20 | 0.00 | 0.00 | 0.00 | 3240. | 2918. | 6 APR 1000 | 46 | 0.00 | 0.00 | 0.00 | 1516. | 1494. |
| 5 APR 0900 | 21 | 0.00 | 0.00 | 0.00 | 3193. | 2986. | 6 APR 1100 | 47 | 0.00 | 0.00 | 0.00 | 1492. | 1462. |
| 5 APR 1000 | 22 | 0.00 | 0.00 | 0.00 | 3116. | 3040. | 6 APR 1200 | 48 | 0.00 | 0.00 | 0.00 | 1468. | 1430. |
| 5 APR 1100 | 23 | 0.00 | 0.00 | 0.00 | 3017. | 3067. | 6 APR 1300 | 49 | 0.00 | 0.00 | 0.00 | 1445. | 1404. |
| 5 APR 1200 | 24 | 0.00 | 0.00 | 0.00 | 2919. | 3040. | 6 APR 1400 | 50 | 0.00 | 0.00 | 0.00 | 1421. | 1397. |
| 5 APR 1300 | 25 | 0.00 | 0.00 | 0.00 | 2825. | 2959. | 6 APR 1500 | 51 | 0.00 | 0.00 | 0.00 | 1399. | 1384. |
| 5 APR 1400 | 26 | 0.00 | 0.00 | 0.00 | 2733. | 2670. | 6 APR 1600 | 52 | 0.00 | 0.00 | 0.00 | 1376. | 1378. |

TOTAL RAINFALL = 1.08, TOTAL LOSS = 0.11, TOTAL EXCESS = 0.96

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 51.00-HR |
|---|---|---|---|---|---|---|
| 3265. | 18.00 | (CFS) | 3212. | 2720. | 2027. | 2027. |
| | | (INCHES) | 0.203 | 0.688 | 1.089 | 1.089 |
| | | (AC-FT) | 1593. | 5395. | 6542. | 6542. |


STATION CINCIN
(O) OUTFLOW, (*) OBSERVED FLOW
800. 1200. 1600. 2000. 2400. 2800. 3200. 3600. 0. 0. 0. 0. 0.
(L) PRECIP, (X) EXCESS
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.3 0.2 0.1 0.0
DAHRMN PER
41300 1.
41400 2.
41500 3.
41600 4.
41700 5.
41800 6.
41900 7.
42000 8.
42100 9.
42200 10.
42300 11.
50000 12.
50100 13.
50200 14.
50300 15.
50400 16.
50500 17.
50600 18.
50700 19.
50800 20.
50900 21.
51000 22.
51100 23.
51200 24.
51300 25.
51400 26.
51500 27.
51600 28.
51700 29.
51800 30.
51900 31.
52000 32.
52100 33.
52200 34.
52300 35.
60000 36.
60100 37.
60200 38.
60300 39.
60400 40.
60500 41.
60600 42.
60700 43.
60800 44.
60900 45.
61000 46.
61100 47.
61200 48.
61300 49.
61400 50.
61500 51.
61600 52.
(-) LIMITS OF OPTIMIZATION

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

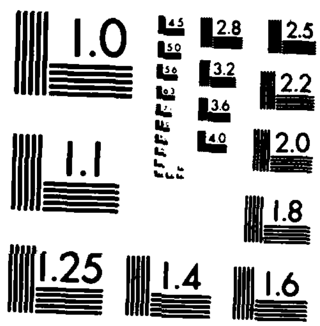
   1          ID        OWEGO CREEK     11-08-72
   2          ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
   3          IT      60 07NOV72    2200      70
   4          IO       1       2
   5          OU      15      40
   6          PG     CAN    3.21
   7          PG  NEWVAL
   8          PI     .00     .00     .01     .03     .06     .03     .07     .09     .02     .09
   9          PI     .02     .08     .07     .29     .26     .31     .20     .23     .13     .06
  10          PI     .02     .04     .05     .08     .06     .08     .08     .05     .00     .01
  11          PI     .01     .00     .00     .00     .00     .00     .00     .00     .00     .00
  12          PG   HUCOR
  13          PI     .00     .10     .00     .00     .10     .00     .10     .10     .10     .00
  14          PI     .10     .10     .10     .30     .20     .30     .10     .20     .10     .20
  15          PI     .00     .10     .10     .10     .10     .00     .10     .10     .00     .00
  16          PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
  17          PG    MTPL
  18          PI     .01     .03     .01     .00     .05     .01     .03     .05     .05     .06
  19          PI     .15     .07     .12     .26     .31     .24     .26     .22     .16     .06
  20          PI     .06     .05     .06     .07     .06     .05     .04     .01     .00     .01
  21          PI     .01     .02     .01     .04     .00     .00     .00     .00     .00     .00

  22          KK   OWEGO
  23          QO      75      75      75      75      76      76      76      77      79      80
  24          QO      81      85      89      98     107     301     495    1398    2300    3335
  25          QO    4370    4753    5136    5292    5448    5399    5350    5249    5148    5129
  26          QO    5110    5015    4920    4711    4502    4145    3787    3457    3127    2884
  27          QO    2640    2435    2230    2060    1890    1765    1640    1541    1441    1369
  28          QO    1296    1227    1158    1115    1072    1042    1012     985     958     931
  29          QO     904     880     856     838     820     801     781     765     748     735
  30          PT     CAN  NEWVAL   HUCOR    MTPL
  31          PW     .13     .40     .31     .11
  32          PR  NEWVAL   HUCOR    MTPL
  33          PW     .56     .31     .13
  34          BA    185.      0.
  35          BF     75.    580.  1.0224
  36          UL    -7.0    -16.
  37          LU     -.7     -.3
  38          ZZ
```

AD-A129 964 WATERSHED MODELLING IN THE CHEMUNG AND UPPER SUSQUEHANNA RIVER BASINS USI..(U) ARMY MILITARY PERSONNEL CENTER ALEXANDRIA VA J C STYRON 20 MAY 83 4/4

UNCLASSIFIED F/G 8/8 NL

END
DATE
FILMED
8 83
DTIC


1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 15 THROUGH 40)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.324 | | 17.25 | | | |
| COMPUTED HYDROGRAPH | 100917. | 0.845 | 3881. | 28.76 | 11.51 | 5698. | 24.00 |
| OBSERVED HYDROGRAPH | 100868. | 0.845 | 3880. | 28.95 | 11.70 | 5448. | 24.00 |
| DIFFERENCE | 49. | 0.000 | 2. | -0.19 | -0.19 | 250. | 0.00 |
| PERCENT DIFFERENCE | 0.05 | | | | -1.66 | 4.59 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 282. | AVERAGE ABSOLUTE ERROR | 246. |
| OBJECTIVE FUNCTION | 275. | AVERAGE PERCENT ABSOLUTE ERROR | 24.84 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 70)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.324 | | 17.25 | | | |
| COMPUTED HYDROGRAPH | 149007. | 1.248 | 2129. | 35.70 | 18.45 | 5698. | 24.00 |
| OBSERVED HYDROGRAPH | 139920. | 1.172 | 1999. | 35.08 | 17.83 | 5448. | 24.00 |
| DIFFERENCE | 9087. | 0.076 | 130. | 0.62 | 0.62 | 250. | 0.00 |
| PERCENT DIFFERENCE | 6.49 | | | | 3.47 | 4.59 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 287. | AVERAGE ABSOLUTE ERROR | 218. |
| OBJECTIVE FUNCTION | 319. | AVERAGE PERCENT ABSOLUTE ERROR | 23.23 |

UNIT HYDROGRAPH
105 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 180. | 680. | 1400. | 2259. | 3175. | 3994. | 4610. | 4983. | 5009. | 4788. |
| 4542. | 4308. | 4087. | 3877. | 3677. | 3488. | 3309. | 3138. | 2977. | 2824. |
| 2679. | 2541. | 2410. | 2286. | 2169. | 2057. | 1951. | 1851. | 1756. | 1665. |
| 1580. | 1499. | 1421. | 1348. | 1279. | 1213. | 1151. | 1092. | 1035. | 982. |
| 932. | 884. | 838. | 795. | 754. | 716. | 679. | 644. | 611. | 579. |
| 549. | 521. | 494. | 469. | 445. | 422. | 400. | 380. | 360. | 342. |
| 324. | 307. | 292. | 277. | 262. | 249. | 236. | 224. | 212. | 201. |
| 191. | 181. | 172. | 163. | 155. | 147. | 139. | 132. | 125. | 119. |
| 113. | 107. | 101. | 96. | 91. | 87. | 82. | 78. | 74. | 70. |
| 66. | 63. | 60. | 57. | 54. | 51. | 48. | 46. | 44. | 41. |
| 39. | 37. | 35. | 33. | 32. | | | | | |

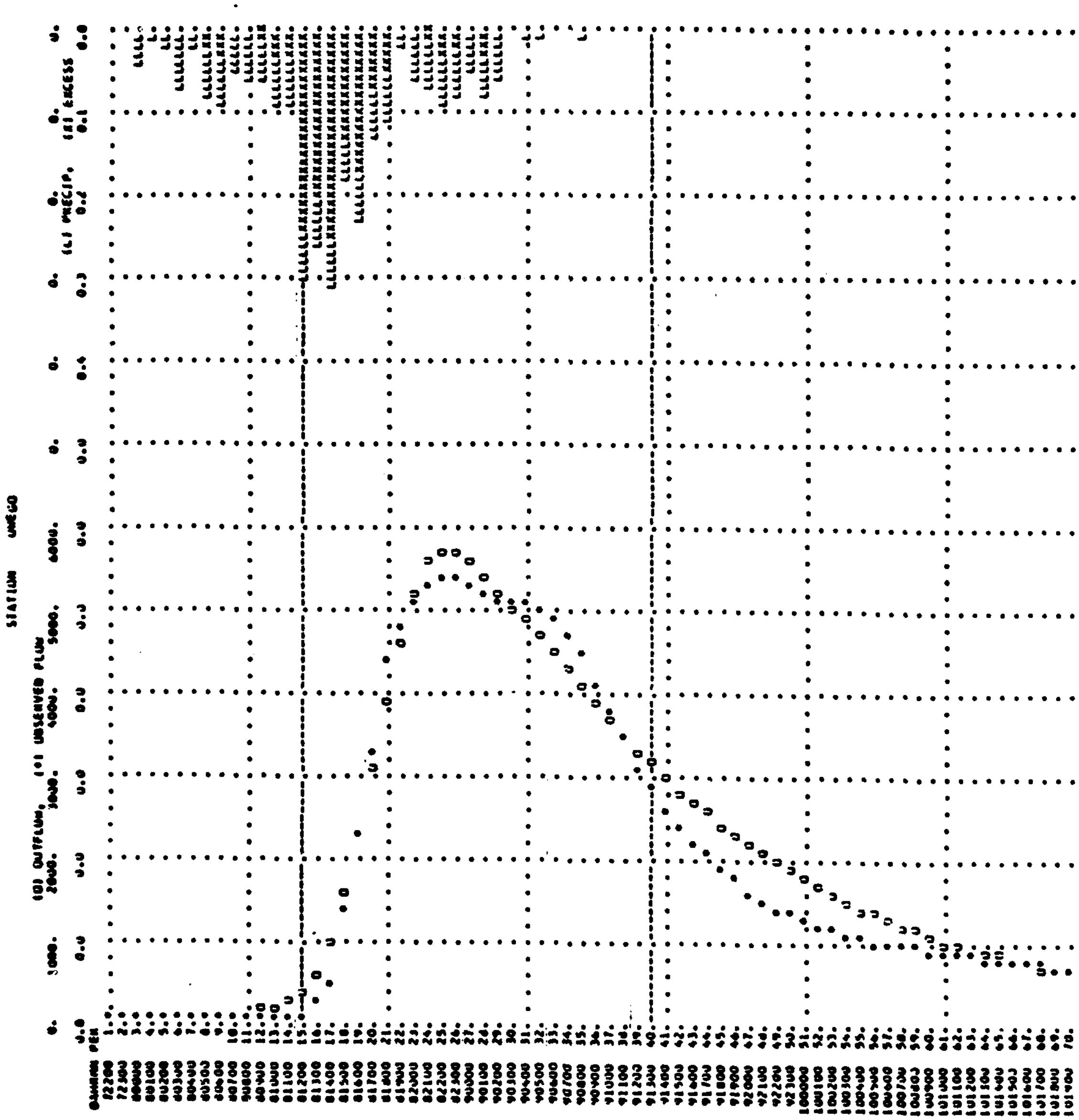
HYDROGRAPH AT STATION OWEGO

| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|
| 7 | NOV | 2200 | 1 | 0.00 | 0.00 | 0.00 | 75. | 75. |
| 7 | NOV | 2300 | 2 | 0.00 | 0.00 | 0.00 | 73. | 75. |
| 8 | NOV | 0000 | 3 | 0.04 | 0.04 | 0.00 | 72. | 75. |
| 8 | NOV | 0100 | 4 | 0.01 | 0.01 | 0.00 | 70. | 75. |
| 8 | NOV | 0200 | 5 | 0.02 | 0.02 | 0.00 | 69. | 76. |
| 8 | NOV | 0300 | 6 | 0.07 | 0.07 | 0.00 | 67. | 76. |
| 8 | NOV | 0400 | 7 | 0.02 | 0.02 | 0.00 | 66. | 76. |
| 8 | NOV | 0500 | 8 | 0.08 | 0.06 | 0.02 | 66. | 77. |
| 8 | NOV | 0600 | 9 | 0.09 | 0.06 | 0.03 | 81. | 79. |
| 8 | NOV | 0700 | 10 | 0.05 | 0.05 | 0.00 | 110. | 80. |
| 8 | NOV | 0800 | 11 | 0.06 | 0.06 | 0.00 | 149. | 81. |
| 8 | NOV | 0900 | 12 | 0.06 | 0.06 | 0.01 | 195. | 85. |
| 8 | NOV | 1000 | 13 | 0.09 | 0.06 | 0.03 | 248. | 89. |
| 8 | NOV | 1100 | 14 | 0.09 | 0.06 | 0.03 | 312. | 98. |
| 8 | NOV | 1200 | 15 | 0.30 | 0.06 | 0.24 | 425. | 107. |
| 8 | NOV | 1300 | 16 | 0.26 | 0.06 | 0.20 | 649. | 301. |
| 8 | NOV | 1400 | 17 | 0.31 | 0.06 | 0.25 | 1025. | 495. |
| 8 | NOV | 1500 | 18 | 0.18 | 0.06 | 0.13 | 1571. | 1398. |
| 8 | NOV | 1600 | 19 | 0.23 | 0.06 | 0.17 | 2274. | 2300. |
| 8 | NOV | 1700 | 20 | 0.13 | 0.06 | 0.07 | 3080. | 3335. |
| 8 | NOV | 1800 | 21 | 0.11 | 0.06 | 0.05 | 3899. | 4370. |
| 8 | NOV | 1900 | 22 | 0.02 | 0.02 | 0.00 | 4638. | 4753. |
| 8 | NOV | 2000 | 23 | 0.06 | 0.06 | 0.00 | 5205. | 5136. |
| 8 | NOV | 2100 | 24 | 0.07 | 0.06 | 0.01 | 5552. | 5292. |
| 8 | NOV | 2200 | 25 | 0.09 | 0.06 | 0.03 | 5698. | 5448. |
| 8 | NOV | 2300 | 26 | 0.08 | 0.06 | 0.02 | 5692. | 5399. |
| 9 | NOV | 0000 | 27 | 0.05 | 0.05 | 0.00 | 5583. | 5350. |
| 9 | NOV | 0100 | 28 | 0.08 | 0.06 | 0.03 | 5413. | 5249. |
| 9 | NOV | 0200 | 29 | 0.06 | 0.06 | 0.00 | 5227. | 5148. |
| 9 | NOV | 0300 | 30 | 0.00 | 0.00 | 0.00 | 5040. | 5129. |
| 9 | NOV | 0400 | 31 | 0.01 | 0.01 | 0.00 | 4858. | 5110. |
| 9 | NOV | 0500 | 32 | 0.01 | 0.01 | 0.00 | 4675. | 5015. |
| 9 | NOV | 0600 | 33 | 0.00 | 0.00 | 0.00 | 4485. | 4920. |
| 9 | NOV | 0700 | 34 | 0.00 | 0.00 | 0.00 | 4286. | 4711. |
| 9 | NOV | 0800 | 35 | 0.01 | 0.01 | 0.00 | 4086. | 4502. |
| 9 | NOV | 0900 | 36 | 0.00 | 0.00 | 0.00 | 3887. | 4145. |
| 9 | NOV | 1000 | 37 | 0.00 | 0.00 | 0.00 | 3690. | 3787. |
| 9 | NOV | 1100 | 38 | 0.00 | 0.00 | 0.00 | 3502. | 3457. |
| 9 | NOV | 1200 | 39 | 0.00 | 0.00 | 0.00 | 3323. | 3127. |
| 9 | NOV | 1300 | 40 | 0.00 | 0.00 | 0.00 | 3153. | 2884. |
| 9 | NOV | 1400 | 41 | 0.00 | 0.00 | 0.00 | 2991. | 2640. |
| 9 | NOV | 1500 | 42 | 0.00 | 0.00 | 0.00 | 2838. | 2435. |
| 9 | NOV | 1600 | 43 | 0.00 | 0.00 | 0.00 | 2693. | 2230. |
| 9 | NOV | 1700 | 44 | 0.00 | 0.00 | 0.00 | 2556. | 2060. |
| 9 | NOV | 1800 | 45 | 0.00 | 0.00 | 0.00 | 2425. | 1890. |
| 9 | NOV | 1900 | 46 | 0.00 | 0.00 | 0.00 | 2301. | 1765. |
| 9 | NOV | 2000 | 47 | 0.00 | 0.00 | 0.00 | 2184. | 1640. |
| 9 | NOV | 2100 | 48 | 0.00 | 0.00 | 0.00 | 2072. | 1541. |
| 9 | NOV | 2200 | 49 | 0.00 | 0.00 | 0.00 | 1966. | 1441. |
| 9 | NOV | 2300 | 50 | 0.00 | 0.00 | 0.00 | 1866. | 1369. |
| 10 | NOV | 0000 | 51 | 0.00 | 0.00 | 0.00 | 1771. | 1296. |
| 10 | NOV | 0100 | 52 | 0.00 | 0.00 | 0.00 | 1680. | 1227. |
| 10 | NOV | 0200 | 53 | 0.00 | 0.00 | 0.00 | 1595. | 1158. |
| 10 | NOV | 0300 | 54 | 0.00 | 0.00 | 0.00 | 1513. | 1115. |
| 10 | NOV | 0400 | 55 | 0.00 | 0.00 | 0.00 | 1436. | 1072. |
| 10 | NOV | 0500 | 56 | 0.00 | 0.00 | 0.00 | 1363. | 1042. |
| 10 | NOV | 0600 | 57 | 0.00 | 0.00 | 0.00 | 1294. | 1012. |
| 10 | NOV | 0700 | 58 | 0.00 | 0.00 | 0.00 | 1228. | 985. |
| 10 | NOV | 0800 | 59 | 0.00 | 0.00 | 0.00 | 1165. | 958. |
| 10 | NOV | 0900 | 60 | 0.00 | 0.00 | 0.00 | 1106. | 931. |
| 10 | NOV | 1000 | 61 | 0.00 | 0.00 | 0.00 | 1050. | 904. |
| 10 | NOV | 1100 | 62 | 0.00 | 0.00 | 0.00 | 996. | 880. |
| 10 | NOV | 1200 | 63 | 0.00 | 0.00 | 0.00 | 946. | 856. |
| 10 | NOV | 1300 | 64 | 0.00 | 0.00 | 0.00 | 897. | 838. |
| 10 | NOV | 1400 | 65 | 0.00 | 0.00 | 0.00 | 852. | 820. |
| 10 | NOV | 1500 | 66 | 0.00 | 0.00 | 0.00 | 809. | 801. |
| 10 | NOV | 1600 | 67 | 0.00 | 0.00 | 0.00 | 768. | 781. |
| 10 | NOV | 1700 | 68 | 0.00 | 0.00 | 0.00 | 729. | 765. |
| 10 | NOV | 1800 | 69 | 0.00 | 0.00 | 0.00 | 692. | 748. |
| 10 | NOV | 1900 | 70 | 0.00 | 0.00 | 0.00 | 656. | 735. |

TOTAL RAINFALL = 2.75, TOTAL LOSS = 1.42, TOTAL EXCESS = 1.32

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 69.00-HR |
|---|---|---|---|---|---|---|
| 5698. | 24.00 | (CFS) | 5526. | 4304. | 2154. | 2154. |
| | | (INCHES) | 0.278 | 0.865 | 1.245 | 1.245 |
| | | (AC-FT) | 2740. | 8536. | 12284. | 12284. |

CUMULATIVE AREA = 105.00 SQ MI


STATION UNEGO
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS
0. 1000. 2000. 3000. 4000. 5000. 6000.

```
                                        HEC-1 INPUT                                              PAGE  1

 LINE       ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

    1       ID        OWEGO CREEK    9-26-75
    2       ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
    3       IT      60 24SEP75    2200      88
    4       IO       1       2
    5       OU      10      55
    6       PG     CAN     5.9
    7       PG   LISLE    3.38
    8       PG    CORT    4.50
    9       PG  NEWVAL
   10       PI     .00     .10     .00     .10     .00     .00     .10     .00     .30     .30
   11       PI     .40     .30     .10     .20     .10     .00     .00     .10     .20     .20
   12       PI     .10     .00     .00     .10     .00     .10     .00     .10     .10     .00
   13       PI     .10     .40     .40     .50     .10     .40     .30     .10     .10     .10
   14       PI     .00     .00     .00     .10     .00     .00     .00     .00     .00     .00
   15       PG    WHPT
   16       PI     .00     .00     .10     .10     .00     .10     .00     .10     .20     .30
   17       PI     .30     .40     .10     .20     .00     .10     .00     .10     .30     .30
   18       PI     .00     .00     .00     .00     .00     .10     .10     .10     .10     .00
   19       PI     .00     .10     .30     .30     .20     .10     .20     .10     .10     .10
   20       PI     .00     .10     .00     .00     .10     .00     .00     .00     .00     .00
   21       PG    MTPL
   22       PI     .01     .04     .05     .05     .06     .04     .02     .08     .20     .60
   23       PI     .25     .15     .00     .10     .05     .05     .03     .00     .02     .39
   24       PI     .07     .10     .04     .02     .03     .00     .01     .14     .35     .11
   25       PI     .14     .25     .40     .47     .07     .21     .19     .10     .06     .00
   26       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00

   27       KK   OWEGO
   28       QO     530     502     484     466     452     457     475     502     540     595
   29       QO     618    1083    1947    2969    3783    4492    4828    5140    5368    5514
   30       QO    5710    5934    6018    6088    6046    5948    5962    6046    6060    6088
   31       QO    6022    5934    5836    6004    6564    7332    8628   10400   12000   13350
   32       QO   14110   14165   14220   13560   12650   11820   11270   10680   10295    9750
   33       QO    9330    8620    8304    7674    7132    6676    6214    5724    5296    4900
   34       QO    4528    4190    3904    3651    3431    3233    3079    2936    2796    2705
   35       QO    2540    2437    2342    2275    2194    2160    2075    1998    1947    1896
   36       QO    1854    1811    1769    1712    1672    1632    1608    1568       0       0
   37       PT     CAN  NEWVAL   LISLE    CORT    MTPL
   38       PW     .18     .42     .12     .03     .25
   39       PR  NEWVAL    WHPT    MTPL
   40       PW     .58     .13     .29
   41       BA    185.      0.
   42       BF    530.   2000.  1.0224
   43       UC    -6.0    -14.
   44       LU     -.7    -.05
   45       ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 10 THROUGH 55)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.583 | | 27.28 | | | |
| COMPUTED HYDROGRAPH | 340783. | 2.854 | 7408. | 37.56 | 10.28 | 13774. | 41.00 |
| OBSERVED HYDROGRAPH | 341887. | 2.864 | 7432. | 37.50 | 10.22 | 14220. | 42.00 |
| DIFFERENCE | -1104. | -0.009 | -24. | 0.06 | 0.06 | -446. | -1.00 |
| PERCENT DIFFERENCE | -0.32 | | | | 0.62 | -3.13 | |

STANDARD ERROR 440. AVERAGE ABSOLUTE ERROR 350.
OBJECTIVE FUNCTION 422. AVERAGE PERCENT ABSOLUTE ERROR 7.91

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 88)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 3.583 | | 27.28 | | | |
| COMPUTED HYDROGRAPH | 442682. | 3.708 | 5030. | 43.85 | 16.57 | 13774. | 41.00 |
| OBSERVED HYDROGRAPH | 445048. | 3.728 | 5057. | 43.91 | 16.64 | 14220. | 42.00 |
| DIFFERENCE | -2366. | -0.020 | -27. | -0.07 | -0.07 | -446. | -1.00 |
| PERCENT DIFFERENCE | -0.53 | | | | -0.40 | -3.13 | |

STANDARD ERROR 331. AVERAGE ABSOLUTE ERROR 234.
OBJECTIVE FUNCTION 379. AVERAGE PERCENT ABSOLUTE ERROR 6.81

UNIT HYDROGRAPH
85 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 204. | 1070. | 2194. | 3501. | 4737. | 5656. | 6149. | 6082. | 5703. | 5341. |
| 5001. | 4683. | 4385. | 4107. | 3846. | 3601. | 3372. | 3158. | 2957. | 2769. |
| 2593. | 2428. | 2274. | 2129. | 1994. | 1867. | 1748. | 1637. | 1533. | 1436. |
| 1344. | 1259. | 1179. | 1104. | 1034. | 968. | 907. | 849. | 795. | 744. |
| 697. | 653. | 611. | 572. | 536. | 502. | 470. | 440. | 412. | 386. |
| 361. | 338. | 317. | 297. | 278. | 260. | 244. | 228. | 214. | 200. |
| 187. | 175. | 164. | 154. | 144. | 135. | 126. | 118. | 111. | 104. |
| 97. | 91. | 85. | 80. | 75. | 70. | 66. | 61. | 57. | 54. |
| 50. | 47. | 44. | 41. | 39. | | | | | |

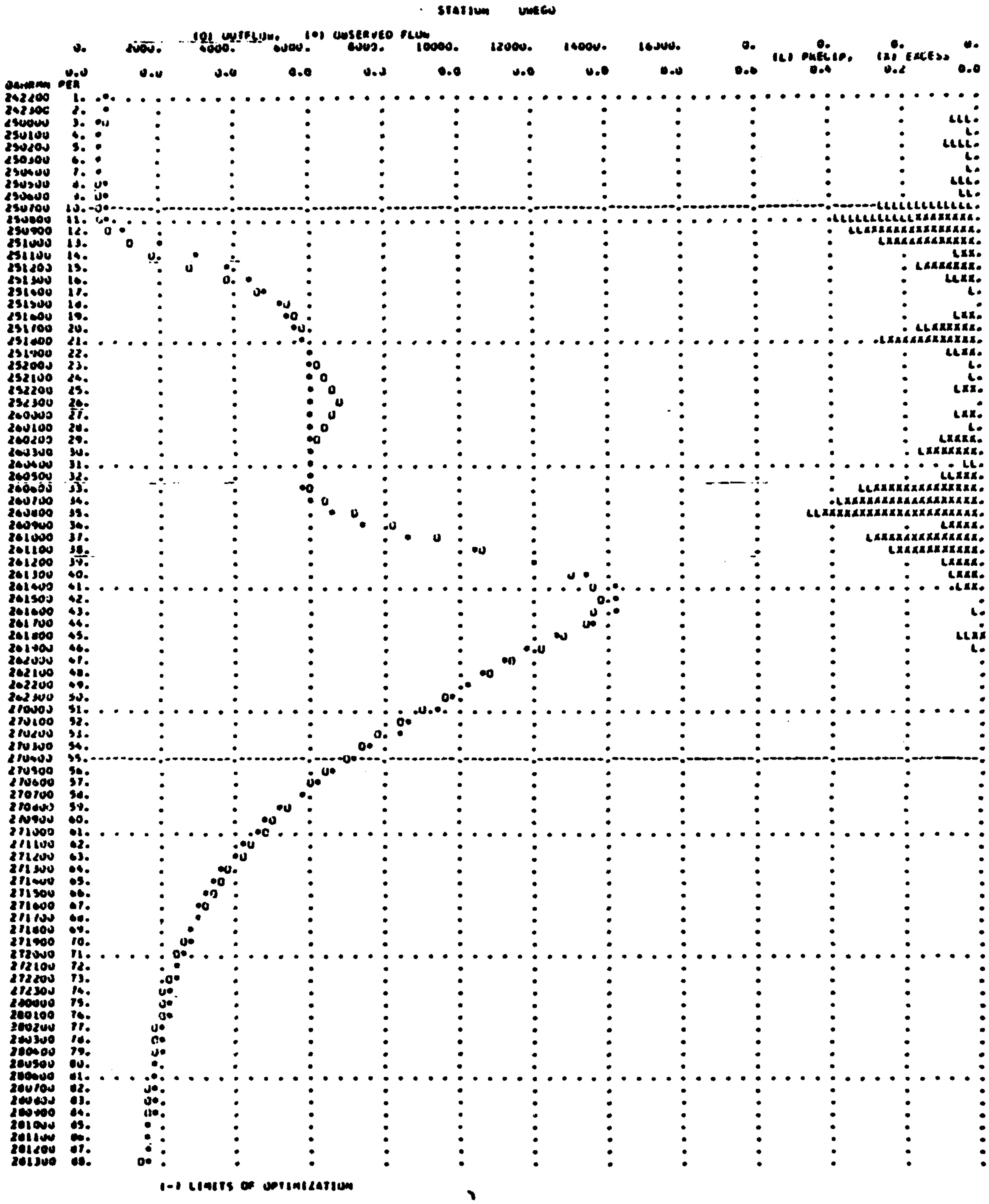
HYDROGRAPH AT STATION UNEGO

| DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA | MON | HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | SEP | 2200 | 1 | 0.00 | 0.00 | 0.00 | 530. | 530. | 26 | SEP | 1800 | 45 | 0.06 | 0.03 | 0.03 | 12762. | 12650. |
| 24 | SEP | 2300 | 2 | 0.00 | 0.00 | 0.00 | 514. | 502. | 26 | SEP | 1900 | 46 | 0.01 | 0.01 | 0.00 | 12108. | 11820. |
| 25 | SEP | 0000 | 3 | 0.07 | 0.07 | 0.00 | 507. | 484. | 26 | SEP | 2000 | 47 | 0.00 | 0.00 | 0.00 | 11437. | 11270. |
| 25 | SEP | 0100 | 4 | 0.03 | 0.03 | 0.00 | 496. | 466. | 26 | SEP | 2100 | 48 | 0.00 | 0.00 | 0.00 | 10774. | 10680. |
| 25 | SEP | 0200 | 5 | 0.08 | 0.08 | 0.00 | 485. | 452. | 26 | SEP | 2200 | 49 | 0.00 | 0.00 | 0.00 | 10140. | 10295. |
| 25 | SEP | 0300 | 6 | 0.02 | 0.02 | 0.00 | 474. | 457. | 26 | SEP | 2300 | 50 | 0.00 | 0.00 | 0.00 | 9539. | 9750. |
| 25 | SEP | 0400 | 7 | 0.02 | 0.02 | 0.00 | 464. | 475. | 27 | SEP | 0000 | 51 | 0.00 | 0.00 | 0.00 | 8965. | 9330. |
| 25 | SEP | 0500 | 8 | 0.06 | 0.06 | 0.00 | 454. | 502. | 27 | SEP | 0100 | 52 | 0.00 | 0.00 | 0.00 | 8411. | 8820. |
| 25 | SEP | 0600 | 9 | 0.04 | 0.04 | 0.00 | 444. | 540. | 27 | SEP | 0200 | 53 | 0.00 | 0.00 | 0.00 | 7884. | 8304. |
| 25 | SEP | 0700 | 10 | 0.25 | 0.25 | 0.00 | 434. | 595. | 27 | SEP | 0300 | 54 | 0.00 | 0.00 | 0.00 | 7390. | 7674. |
| 25 | SEP | 0800 | 11 | 0.36 | 0.22 | 0.15 | 469. | 618. | 27 | SEP | 0400 | 55 | 0.00 | 0.00 | 0.00 | 6927. | 7132. |
| 25 | SEP | 0900 | 12 | 0.34 | 0.03 | 0.31 | 608. | 1083. | 27 | SEP | 0500 | 56 | 0.00 | 0.00 | 0.00 | 6493. | 6676. |
| 25 | SEP | 1000 | 13 | 0.26 | 0.03 | 0.24 | 1143. | 1947. | 27 | SEP | 0600 | 57 | 0.00 | 0.00 | 0.00 | 6087. | 6214. |
| 25 | SEP | 1100 | 14 | 0.07 | 0.03 | 0.04 | 1880. | 2969. | 27 | SEP | 0700 | 58 | 0.00 | 0.00 | 0.00 | 5706. | 5724. |
| 25 | SEP | 1200 | 15 | 0.17 | 0.03 | 0.14 | 2804. | 3783. | 27 | SEP | 0800 | 59 | 0.00 | 0.00 | 0.00 | 5350. | 5296. |
| 25 | SEP | 1300 | 16 | 0.07 | 0.03 | 0.04 | 3797. | 4492. | 27 | SEP | 0900 | 60 | 0.00 | 0.00 | 0.00 | 5016. | 4900. |
| 25 | SEP | 1400 | 17 | 0.03 | 0.03 | 0.00 | 4686. | 4828. | 27 | SEP | 1000 | 61 | 0.00 | 0.00 | 0.00 | 4703. | 4528. |
| 25 | SEP | 1500 | 18 | 0.01 | 0.01 | 0.00 | 5319. | 5140. | 27 | SEP | 1100 | 62 | 0.00 | 0.00 | 0.00 | 4410. | 4190. |
| 25 | SEP | 1600 | 19 | 0.07 | 0.03 | 0.04 | 5624. | 5368. | 27 | SEP | 1200 | 63 | 0.00 | 0.00 | 0.00 | 4135. | 3904. |
| 25 | SEP | 1700 | 20 | 0.16 | 0.03 | 0.13 | 5705. | 5514. | 27 | SEP | 1300 | 64 | 0.00 | 0.00 | 0.00 | 3878. | 3651. |
| 25 | SEP | 1800 | 21 | 0.26 | 0.03 | 0.23 | 5765. | 5710. | 27 | SEP | 1400 | 65 | 0.00 | 0.00 | 0.00 | 3637. | 3431. |
| 25 | SEP | 1900 | 22 | 0.08 | 0.03 | 0.05 | 5913. | 5934. | 27 | SEP | 1500 | 66 | 0.00 | 0.00 | 0.00 | 3411. | 3233. |
| 25 | SEP | 2000 | 23 | 0.03 | 0.03 | 0.00 | 6135. | 6018. | 27 | SEP | 1600 | 67 | 0.00 | 0.00 | 0.00 | 3199. | 3079. |
| 25 | SEP | 2100 | 24 | 0.01 | 0.01 | 0.00 | 6398. | 6088. | 27 | SEP | 1700 | 68 | 0.00 | 0.00 | 0.00 | 3001. | 2936. |
| 25 | SEP | 2200 | 25 | 0.06 | 0.03 | 0.03 | 6623. | 6046. | 27 | SEP | 1800 | 69 | 0.00 | 0.00 | 0.00 | 2815. | 2796. |
| 25 | SEP | 2300 | 26 | 0.01 | 0.01 | 0.00 | 6726. | 5948. | 27 | SEP | 1900 | 70 | 0.00 | 0.00 | 0.00 | 2641. | 2705. |
| 26 | SEP | 0000 | 27 | 0.07 | 0.03 | 0.04 | 6688. | 5962. | 27 | SEP | 2000 | 71 | 0.00 | 0.00 | 0.00 | 2478. | 2540. |
| 26 | SEP | 0100 | 28 | 0.02 | 0.02 | 0.00 | 6461. | 6046. | 27 | SEP | 2100 | 72 | 0.00 | 0.00 | 0.00 | 2325. | 2437. |
| 26 | SEP | 0200 | 29 | 0.11 | 0.03 | 0.08 | 6205. | 6060. | 27 | SEP | 2200 | 73 | 0.00 | 0.00 | 0.00 | 2182. | 2342. |
| 26 | SEP | 0300 | 30 | 0.17 | 0.03 | 0.14 | 6032. | 6088. | 27 | SEP | 2300 | 74 | 0.00 | 0.00 | 0.00 | 2048. | 2275. |
| 26 | SEP | 0400 | 31 | 0.03 | 0.03 | 0.00 | 5963. | 6022. | 28 | SEP | 0000 | 75 | 0.00 | 0.00 | 0.00 | 1973. | 2194. |
| 26 | SEP | 0500 | 32 | 0.10 | 0.03 | 0.07 | 5966. | 5934. | 28 | SEP | 0100 | 76 | 0.00 | 0.00 | 0.00 | 1930. | 2160. |
| 26 | SEP | 0600 | 33 | 0.31 | 0.03 | 0.28 | 6098. | 5836. | 28 | SEP | 0200 | 77 | 0.00 | 0.00 | 0.00 | 1887. | 2075. |
| 26 | SEP | 0700 | 34 | 0.38 | 0.03 | 0.35 | 6455. | 6004. | 28 | SEP | 0300 | 78 | 0.00 | 0.00 | 0.00 | 1846. | 1998. |
| 26 | SEP | 0800 | 35 | 0.46 | 0.03 | 0.43 | 7144. | 6564. | 28 | SEP | 0400 | 79 | 0.00 | 0.00 | 0.00 | 1806. | 1947. |
| 26 | SEP | 0900 | 36 | 0.10 | 0.03 | 0.07 | 8145. | 7332. | 28 | SEP | 0500 | 80 | 0.00 | 0.00 | 0.00 | 1766. | 1896. |
| 26 | SEP | 1000 | 37 | 0.30 | 0.03 | 0.27 | 9338. | 8828. | 28 | SEP | 0600 | 81 | 0.00 | 0.00 | 0.00 | 1727. | 1854. |
| 26 | SEP | 1100 | 38 | 0.25 | 0.03 | 0.22 | 10662. | 10400. | 28 | SEP | 0700 | 82 | 0.00 | 0.00 | 0.00 | 1689. | 1811. |
| 26 | SEP | 1200 | 39 | 0.10 | 0.03 | 0.07 | 11940. | 12000. | 28 | SEP | 0800 | 83 | 0.00 | 0.00 | 0.00 | 1652. | 1769. |
| 26 | SEP | 1300 | 40 | 0.09 | 0.03 | 0.06 | 12943. | 13350. | 28 | SEP | 0900 | 84 | 0.00 | 0.00 | 0.00 | 1616. | 1712. |
| 26 | SEP | 1400 | 41 | 0.07 | 0.03 | 0.04 | 13562. | 14110. | 28 | SEP | 1000 | 85 | 0.00 | 0.00 | 0.00 | 1581. | 1672. |
| 26 | SEP | 1500 | 42 | 0.00 | 0.00 | 0.00 | 13774. | 14165. | 28 | SEP | 1100 | 86 | 0.00 | 0.00 | 0.00 | 1546. | 1632. |
| 26 | SEP | 1600 | 43 | 0.01 | 0.01 | 0.00 | 13675. | 14220. | 28 | SEP | 1200 | 87 | 0.00 | 0.00 | 0.00 | 1512. | 1608. |
| 26 | SEP | 1700 | 44 | 0.00 | 0.00 | 0.00 | 13325. | 13560. | 28 | SEP | 1300 | 88 | 0.00 | 0.00 | 0.00 | 1479. | 1568. |

TOTAL RAINFALL = 5.19, TOTAL LOSS = 1.61, TOTAL EXCESS = 3.58

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 87.00-HR |
|---|---|---|---|---|---|---|
| 13774. | 41.00 | (CFS) | 13272. | 9995. | 5985. | 5077. |
| | | (INCHES) | 0.667 | 2.009 | 3.609 | 3.703 |
| | | (AC-FT) | 6581. | 19825. | 35611. | 36502. |

CUMULATIVE AREA = 185.00 SQ MI


STATION OWEGO
(O) OUTFLOW, (*) OBSERVED FLOW
0. 2000. 4000. 6000. 8000. 10000. 12000. 14000. 16000.
(L) PRECIP.
(X) EXCESS
DAHRMN PER
I-I LIMITS OF OPTIMIZATION

HEC-1 INPUT                                                                                          PAGE 1

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        OWEGO CREEK    10-09-76
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3           IT       60 07OCT76    1700      90
  4           IO        1       2
  5           OU       35      65
  6           PG      CAN    3.13
  7           PG   NEWVAL
  8           PI      .00     .00     .00     .00     .00     .10     .10     .10     .00     .00
  9           PI      .00     .10     .00     .00     .00     .00     .00     .00     .00     .00
 10           PI      .00     .10     .00     .00     .00     .00     .00     .00     .10     .00
 11           PI      .00     .00     .10     .10     .10     .20     .10     .10     .10     .20
 12           PI      .30     .30     .50     .40     .10     .00     .10     .00     .00     .00
 13           PI      .00     .00     .00     .00     .10     .00     .00     .00     .00     .00
 14           PG    HUCOR
 15           PI      .00     .00     .10     .10     .00     .00     .10     .10     .10     .00
 16           PI      .00     .00     .00     .00     .00     .00     .10     .00     .00     .00
 17           PI      .00     .00     .10     .00     .00     .00     .00     .00     .00     .00
 18           PI      .00     .00     .00     .10     .10     .20     .00     .10     .20     .20
 19           PI      .20     .30     .30     .40     .20     .00     .10     .00     .00     .00
 20           PI      .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 21           PG     MTPL
 22           PI      .10     .01     .07     .05     .02     .03     .14     .27     .05     .01
 23           PI      .09     .06     .00     .00     .05     .00     .00     .01     .04     .00
 24           PI      .00     .00     .00     .00     .00     .00     .00     .00     .03     .02
 25           PI      .00     .01     .03     .09     .10     .11     .11     .05     .07     .18
 26           PI      .19     .26     .29     .26     .06     .04     .04     .03     .02     .01
 27           PI      .04     .01     .00     .00     .00     .00     .00     .00     .00     .00

 28           KK    OWEGO
 29           QO       45      45      45      46      46      46      47      48      51      51
 30           QO       51      51      51      51      52      52      52      54      54      55
 31           QO       57      60      66      79      89      98     121     139     139     139
 32           QO      139     137     135     137     142     147     149     173     218     293
 33           QO      457     760    1277    2194    3266    4256    4948    5536    6074    6508
 34           QO     6876    6956    6764    6172    5356    4852    4540    4408    4360    4201
 35           QO     4058    3761    3387    2947    2550    2329    2168    2057    1947    1769
 36           QO     1744    1672    1616    1528    1464    1416    1345    1300    1247    1210
 37           QO     1172    1143    1097    1053    1025    1004     976     948     920     900
 38           PT      CAN  NEWVAL   HUCOR    MTPL
 39           PW      .18     .40     .31     .11
 40           PR   NEWVAL   HUCOR    MTPL
 41           PW      .56     .31     .13
 42           BA     185.      0.
 43           BF      45.   1100.  1.0224
 44           UC     -6.0    -16.
 45           LU      -.7    -.05
 46           ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 35 THROUGH 65)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.290 | | 42.92 | | | |
| COMPUTED HYDROGRAPH | 107045. | 0.897 | 3453. | 53.67 | 10.75 | 6882. | 50.00 |
| OBSERVED HYDROGRAPH | 107586. | 0.901 | 3471. | 53.46 | 10.54 | 6956. | 51.00 |
| DIFFERENCE | -541. | -0.005 | -17. | 0.21 | 0.21 | -74. | -1.00 |
| PERCENT DIFFERENCE | -0.50 | | | | 1.97 | -1.06 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 284. | AVERAGE ABSOLUTE ERROR | 225. |
| OBJECTIVE FUNCTION | 304. | AVERAGE PERCENT ABSOLUTE ERROR | 15.54 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 90)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.290 | | 42.92 | | | |
| COMPUTED HYDROGRAPH | 146909. | 1.231 | 1632. | 59.11 | 16.19 | 6882. | 50.00 |
| OBSERVED HYDROGRAPH | 145164. | 1.216 | 1613. | 58.34 | 15.42 | 6956. | 51.00 |
| DIFFERENCE | 1745. | 0.015 | 19. | 0.77 | 0.77 | -74. | -1.00 |
| PERCENT DIFFERENCE | 1.20 | | | | 5.02 | -1.06 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 209. | AVERAGE ABSOLUTE ERROR | 122. |
| OBJECTIVE FUNCTION | 293. | AVERAGE PERCENT ABSOLUTE ERROR | 12.71 |

UNIT HYDROGRAPH
91 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 258. | 973. | 1949. | 3201. | 4359. | 5245. | 5764. | 5772. | 5456. | 5132. |
| 4827. | 4540. | 4270. | 4017. | 3778. | 3553. | 3342. | 3144. | 2957. | 2781. |
| 2616. | 2460. | 2314. | 2177. | 2047. | 1926. | 1811. | 1704. | 1602. | 1507. |
| 1418. | 1333. | 1254. | 1180. | 1109. | 1044. | 982. | 923. | 868. | 817. |
| 768. | 723. | 680. | 639. | 601. | 565. | 532. | 500. | 471. | 443. |
| 416. | 392. | 368. | 346. | 326. | 306. | 288. | 271. | 255. | 240. |
| 226. | 212. | 200. | 188. | 177. | 166. | 156. | 147. | 138. | 130. |
| 122. | 115. | 108. | 102. | 96. | 90. | 85. | 80. | 75. | 70. |
| 66. | 62. | 59. | 55. | 52. | 49. | 46. | 43. | 41. | 38. |
| 36. | | | | | | | | | |

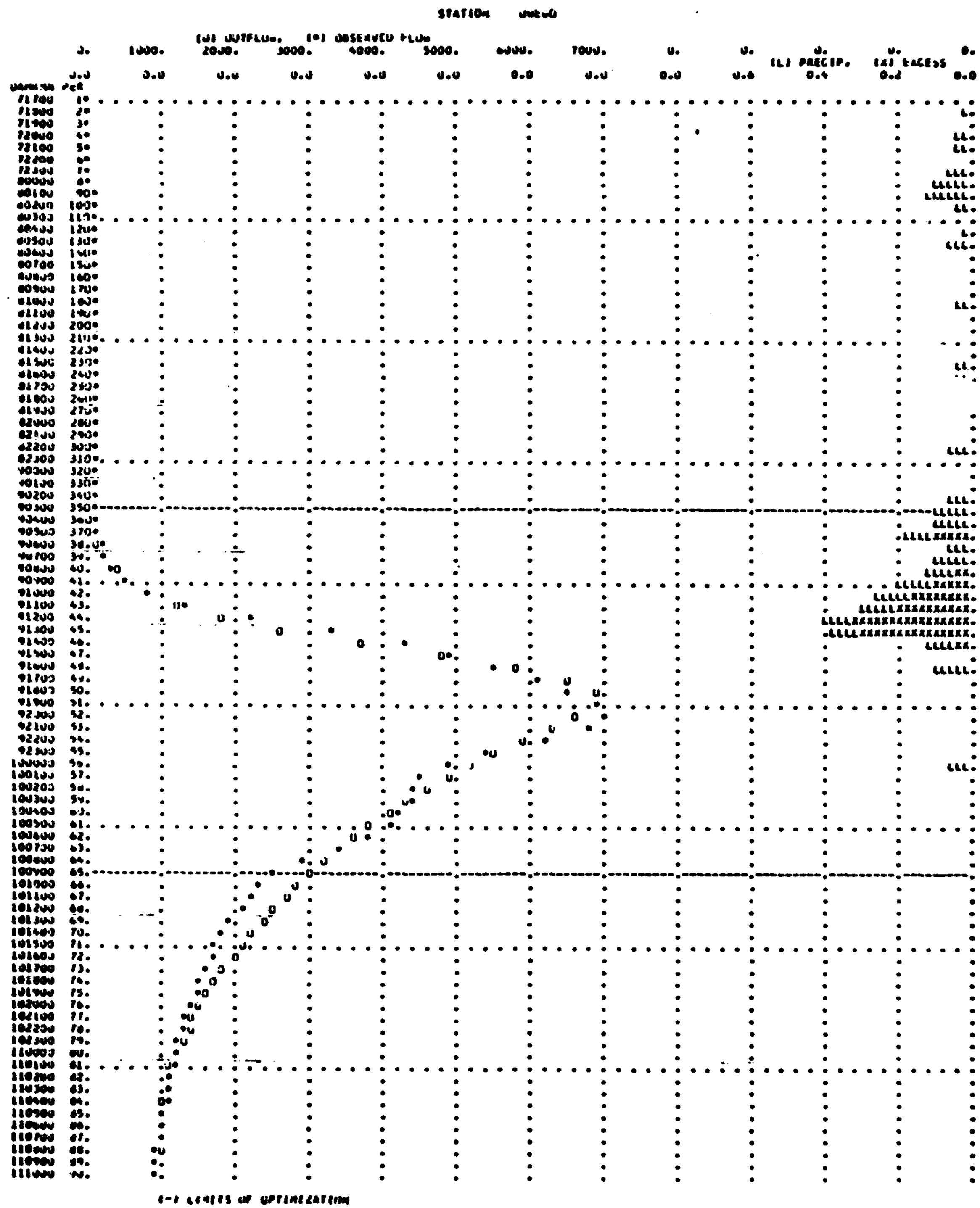
HYDROGRAPH AT STATION OWEGO

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 OCT 1700 | 1 | 0.00 | 0.00 | 0.00 | 45. | 45. | 9 OCT 1400 | 46 | 0.12 | 0.09 | 0.04 | 3714. | 4256. |
| 7 OCT 1800 | 2 | 0.01 | 0.01 | 0.00 | 44. | 45. | 9 OCT 1500 | 47 | 0.01 | 0.01 | 0.00 | 4836. | 4948. |
| 7 OCT 1900 | 3 | 0.00 | 0.00 | 0.00 | 43. | 45. | 9 OCT 1600 | 48 | 0.09 | 0.09 | 0.01 | 5424. | 5536. |
| 7 OCT 2000 | 4 | 0.04 | 0.04 | 0.00 | 42. | 46. | 9 OCT 1700 | 49 | 0.00 | 0.00 | 0.00 | 6528. | 6074. |
| 7 OCT 2100 | 5 | 0.04 | 0.04 | 0.00 | 41. | 46. | 9 OCT 1800 | 50 | 0.00 | 0.00 | 0.00 | 6677. | 6508. |
| 7 OCT 2200 | 6 | 0.00 | 0.00 | 0.00 | 40. | 46. | 9 OCT 1900 | 51 | 0.00 | 0.00 | 0.00 | 6882. | 6876. |
| 7 OCT 2300 | 7 | 0.06 | 0.06 | 0.00 | 39. | 47. | 9 OCT 2000 | 52 | 0.01 | 0.01 | 0.00 | 6626. | 6956. |
| 8 OCT 0000 | 8 | 0.10 | 0.10 | 0.00 | 39. | 48. | 9 OCT 2100 | 53 | 0.00 | 0.00 | 0.00 | 6261. | 6764. |
| 8 OCT 0100 | 9 | 0.12 | 0.12 | 0.00 | 38. | 51. | 9 OCT 2200 | 54 | 0.00 | 0.00 | 0.00 | 5896. | 6172. |
| 8 OCT 0200 | 10 | 0.04 | 0.04 | 0.00 | 37. | 51. | 9 OCT 2300 | 55 | 0.00 | 0.00 | 0.00 | 5548. | 5356. |
| 8 OCT 0300 | 11 | 0.00 | 0.00 | 0.00 | 36. | 51. | 10 OCT 0000 | 56 | 0.06 | 0.06 | 0.00 | 5219. | 4852. |
| 8 OCT 0400 | 12 | 0.01 | 0.01 | 0.00 | 35. | 51. | 10 OCT 0100 | 57 | 0.00 | 0.00 | 0.00 | 4909. | 4540. |
| 8 OCT 0500 | 13 | 0.06 | 0.06 | 0.00 | 34. | 51. | 10 OCT 0200 | 58 | 0.00 | 0.00 | 0.00 | 4618. | 4408. |
| 8 OCT 0600 | 14 | 0.00 | 0.00 | 0.00 | 34. | 51. | 10 OCT 0300 | 59 | 0.00 | 0.00 | 0.00 | 4344. | 4360. |
| 8 OCT 0700 | 15 | 0.00 | 0.00 | 0.00 | 33. | 52. | 10 OCT 0400 | 60 | 0.00 | 0.00 | 0.00 | 4086. | 4201. |
| 8 OCT 0800 | 16 | 0.01 | 0.01 | 0.00 | 32. | 52. | 10 OCT 0500 | 61 | 0.00 | 0.00 | 0.00 | 3844. | 4058. |
| 8 OCT 0900 | 17 | 0.00 | 0.00 | 0.00 | 32. | 52. | 10 OCT 0600 | 62 | 0.00 | 0.00 | 0.00 | 3616. | 3761. |
| 8 OCT 1000 | 18 | 0.03 | 0.03 | 0.00 | 31. | 54. | 10 OCT 0700 | 63 | 0.00 | 0.00 | 0.00 | 3402. | 3387. |
| 8 OCT 1100 | 19 | 0.00 | 0.00 | 0.00 | 30. | 54. | 10 OCT 0800 | 64 | 0.00 | 0.00 | 0.00 | 3200. | 2947. |
| 8 OCT 1200 | 20 | 0.01 | 0.01 | 0.00 | 30. | 55. | 10 OCT 0900 | 65 | 0.00 | 0.00 | 0.00 | 3010. | 2550. |
| 8 OCT 1300 | 21 | 0.00 | 0.00 | 0.00 | 29. | 57. | 10 OCT 1000 | 66 | 0.00 | 0.00 | 0.00 | 2832. | 2329. |
| 8 OCT 1400 | 22 | 0.00 | 0.00 | 0.00 | 28. | 60. | 10 OCT 1100 | 67 | 0.00 | 0.00 | 0.00 | 2664. | 2168. |
| 8 OCT 1500 | 23 | 0.06 | 0.06 | 0.00 | 28. | 66. | 10 OCT 1200 | 68 | 0.00 | 0.00 | 0.00 | 2506. | 2057. |
| 8 OCT 1600 | 24 | 0.03 | 0.03 | 0.00 | 27. | 79. | 10 OCT 1300 | 69 | 0.00 | 0.00 | 0.00 | 2357. | 1947. |
| 8 OCT 1700 | 25 | 0.00 | 0.00 | 0.00 | 26. | 89. | 10 OCT 1400 | 70 | 0.00 | 0.00 | 0.00 | 2218. | 1769. |
| 8 OCT 1800 | 26 | 0.00 | 0.00 | 0.00 | 26. | 98. | 10 OCT 1500 | 71 | 0.00 | 0.00 | 0.00 | 2086. | 1744. |
| 8 OCT 1900 | 27 | 0.00 | 0.00 | 0.00 | 25. | 121. | 10 OCT 1600 | 72 | 0.00 | 0.00 | 0.00 | 1963. | 1672. |
| 8 OCT 2000 | 28 | 0.00 | 0.00 | 0.00 | 25. | 139. | 10 OCT 1700 | 73 | 0.00 | 0.00 | 0.00 | 1846. | 1616. |
| 8 OCT 2100 | 29 | 0.00 | 0.00 | 0.00 | 24. | 139. | 10 OCT 1800 | 74 | 0.00 | 0.00 | 0.00 | 1737. | 1528. |
| 8 OCT 2200 | 30 | 0.06 | 0.06 | 0.00 | 24. | 139. | 10 OCT 1900 | 75 | 0.00 | 0.00 | 0.00 | 1634. | 1464. |
| 8 OCT 2300 | 31 | 0.00 | 0.00 | 0.00 | 23. | 139. | 10 OCT 2000 | 76 | 0.00 | 0.00 | 0.00 | 1537. | 1416. |
| 9 OCT 0000 | 32 | 0.00 | 0.00 | 0.00 | 23. | 137. | 10 OCT 2100 | 77 | 0.00 | 0.00 | 0.00 | 1446. | 1345. |
| 9 OCT 0100 | 33 | 0.00 | 0.00 | 0.00 | 22. | 135. | 10 OCT 2200 | 78 | 0.00 | 0.00 | 0.00 | 1361. | 1300. |
| 9 OCT 0200 | 34 | 0.06 | 0.06 | 0.00 | 22. | 137. | 10 OCT 2300 | 79 | 0.00 | 0.00 | 0.00 | 1280. | 1247. |
| 9 OCT 0300 | 35 | 0.10 | 0.10 | 0.00 | 21. | 142. | 11 OCT 0000 | 80 | 0.00 | 0.00 | 0.00 | 1204. | 1210. |
| 9 OCT 0400 | 36 | 0.10 | 0.10 | 0.00 | 21. | 147. | 11 OCT 0100 | 81 | 0.00 | 0.00 | 0.00 | 1133. | 1172. |
| 9 OCT 0500 | 37 | 0.19 | 0.09 | 0.10 | 48. | 149. | 11 OCT 0200 | 82 | 0.00 | 0.00 | 0.00 | 1088. | 1143. |
| 9 OCT 0600 | 38 | 0.07 | 0.07 | 0.00 | 121. | 173. | 11 OCT 0300 | 83 | 0.00 | 0.00 | 0.00 | 1064. | 1097. |
| 9 OCT 0700 | 39 | 0.09 | 0.09 | 0.01 | 224. | 218. | 11 OCT 0400 | 84 | 0.00 | 0.00 | 0.00 | 1041. | 1053. |
| 9 OCT 0800 | 40 | 0.13 | 0.09 | 0.04 | 367. | 293. | 11 OCT 0500 | 85 | 0.00 | 0.00 | 0.00 | 1018. | 1025. |
| 9 OCT 0900 | 41 | 0.19 | 0.09 | 0.11 | 549. | 457. | 11 OCT 0600 | 86 | 0.00 | 0.00 | 0.00 | 996. | 1004. |
| 9 OCT 1000 | 42 | 0.25 | 0.09 | 0.17 | 811. | 760. | 11 OCT 0700 | 87 | 0.00 | 0.00 | 0.00 | 974. | 976. |
| 9 OCT 1100 | 43 | 0.29 | 0.09 | 0.21 | 1205. | 1277. | 11 OCT 0800 | 88 | 0.00 | 0.00 | 0.00 | 952. | 948. |
| 9 OCT 1200 | 44 | 0.41 | 0.09 | 0.32 | 1791. | 2194. | 11 OCT 0900 | 89 | 0.00 | 0.00 | 0.00 | 932. | 920. |
| 9 OCT 1300 | 45 | 0.38 | 0.09 | 0.29 | 2641. | 3266. | 11 OCT 1000 | 90 | 0.00 | 0.00 | 0.00 | 911. | 900. |

TOTAL RAINFALL = 3.22, TOTAL LOSS = 1.93, TOTAL EXCESS = 1.29

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 89.00-HR |
|---|---|---|---|---|---|---|
| 6882. | 50.00 | (CFS) | 6506. | 4573. | 2025. | 1645. |
| | | (INCHES) | 0.327 | 0.919 | 1.221 | 1.227 |
| | | (AC-FT) | 3226. | 9069. | 12049. | 12102. |

CUMULATIVE AREA = 185.00 SQ MI


STATION
(O) OUTFLOW, (*) OBSERVED FLOW
(L) PRECIP, (X) EXCESS
(-) LIMITS OF OPTIMIZATION

HEC-1 INPUT PAGE 1

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LINE      ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1       ID        OWEGO CREEK    9-25-77
  2       ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3       IT      60 24SEP77    1300     84
  4       IO       1       2
  5       JU       5      30
  6       PG     CAN    2.51
  7       PG  NEWVAL
  8       PI     .10     .00     .00     .00     .20     .00     .10     .00     .20     .10
  9       PI     .40     .20     .10     .20     .10     .20     .00     .00     .00     .00
 10       PI     .00     .00     .00     .00     .00     .00     .00     .10     .00     .00
 11       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 12       PI     .00     .00     .10     .10     .00     .10     .00     .00     .00     .00
 13       PI     .00     .00     .20     .00     .00     .00     .00     .00     .00     .00
 14       PG   HUCCR
 15       PI     .00     .00     .20     .10     .10     .10     .00     .10     .10     .10
 16       PI     .30     .30     .20     .20     .10     .00     .00     .10     .00     .00
 17       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 18       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 19       PI     .00     .10     .00     .10     .10     .00     .00     .00     .00     .10
 20       PI     .10     .00     .00     .00     .00     .00     .00     .00     .00     .00
 21       PG    MTPL
 22       PI     .00     .00     .08     .10     .07     .05     .06     .09     .13     .27
 23       PI     .27     .22     .11     .11     .04     .00     .00     .00     .00     .00
 24       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 25       PI     .00     .00     .00     .00     .00     .00     .00     .00     .00     .00
 26       PI     .00     .00     .00     .05     .11     .01     .00     .00     .00     .04
 27       PI     .00     .10     .00     .00     .00     .00     .00     .00     .00     .00

 28       KK   OWEGO
 29       QO     380     376     376     380     380     389     389     412     470     621
 30       QO    1097    1712    2374    3178    4014    4864    5570    6000    6382    6494
 31       QO    6456    6326    6004    5548    5104    4768    4492    4311    4190    3981
 32       QO    3739    3453    3035    2643    2410    2266    2160    2066    1981    1913
 33       QO    1854    1794    1760    1744    1752    1794    1836    1905    1964    2032
 34       QO    2075    2083    2075    2049    2049    2092    2176    2248    2284    2284
 35       QO    2230    2143    2058    1981    1913    1828    1752    1672    1608    1552
 36       QO    1488    1440    1390    1360    1315    1277    1248    1202    1173    1135
 37       QO    1098    1067    1039    1011       0       0       0       0       0       0
 38       PT     CAN  NEWVAL   HUCUR    MTPL
 39       PW     .18     .40     .31     .11
 40       PR  NEWVAL   HUCUR    MTPL
 41       PW     .56     .31     .13
 42       BA    185.      0.
 43       BF    380.   1500.  1.0224
 44       UC    -7.0    -18.
 45       LU     -.3    -.05
 46       ZZ
```

## COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

### STATISTICS BASED ON OPTIMIZATION REGION (ORDINATES 5 THROUGH 30)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.532 | | 17.72 | | | |
| COMPUTED HYDROGRAPH | 96061. | 0.805 | 3695. | 20.93 | 3.21 | 6478. | 19.00 |
| OBSERVED HYDROGRAPH | 95526. | 0.800 | 3674. | 20.95 | 3.23 | 6494. | 19.00 |
| DIFFERENCE | 535. | 0.004 | 21. | -0.02 | -0.02 | -16. | 0.00 |
| PERCENT DIFFERENCE | 0.56 | | | | -0.52 | -0.25 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 138. | AVERAGE ABSOLUTE ERROR | 114. |
| OBJECTIVE FUNCTION | 134. | AVERAGE PERCENT ABSOLUTE ERROR | 8.35 |

### STATISTICS BASED ON FULL HYDROGRAPH (ORDINATES 1 THROUGH 84)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.532 | | 17.72 | | | |
| COMPUTED HYDROGRAPH | 196727. | 1.648 | 2342. | 36.35 | 18.63 | 6478. | 19.00 |
| OBSERVED HYDROGRAPH | 198531. | 1.663 | 2363. | 37.68 | 19.96 | 6494. | 19.00 |
| DIFFERENCE | -1804. | -0.015 | -21. | -1.32 | -1.32 | -16. | 0.00 |
| PERCENT DIFFERENCE | -0.91 | | | | -6.63 | -0.25 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 304. | AVERAGE ABSOLUTE ERROR | 232. |
| OBJECTIVE FUNCTION | 301. | AVERAGE PERCENT ABSOLUTE ERROR | 13.42 |

UNIT HYDROGRAPH
98 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 303. | 1143. | 2351. | 3677. | 4795. | 5469. | 5544. | 5258. | 4970. | 4698. |
| 4441. | 4198. | 3969. | 3751. | 3546. | 3352. | 3169. | 2995. | 2832. | 2677. |
| 2530. | 2392. | 2261. | 2137. | 2020. | 1910. | 1805. | 1707. | 1613. | 1525. |
| 1441. | 1363. | 1289. | 1218. | 1151. | 1088. | 1028. | 972. | 919. | 869. |
| 821. | 776. | 734. | 694. | 656. | 620. | 586. | 554. | 524. | 495. |
| 468. | 442. | 418. | 395. | 374. | 353. | 334. | 316. | 298. | 282. |
| 267. | 252. | 238. | 225. | 213. | 201. | 190. | 180. | 170. | 161. |
| 152. | 144. | 136. | 128. | 121. | 115. | 108. | 102. | 97. | 92. |
| 87. | 82. | 77. | 73. | 69. | 65. | 62. | 58. | 55. | 52. |
| 49. | 47. | 44. | 42. | 39. | 37. | 35. | 33. | | |

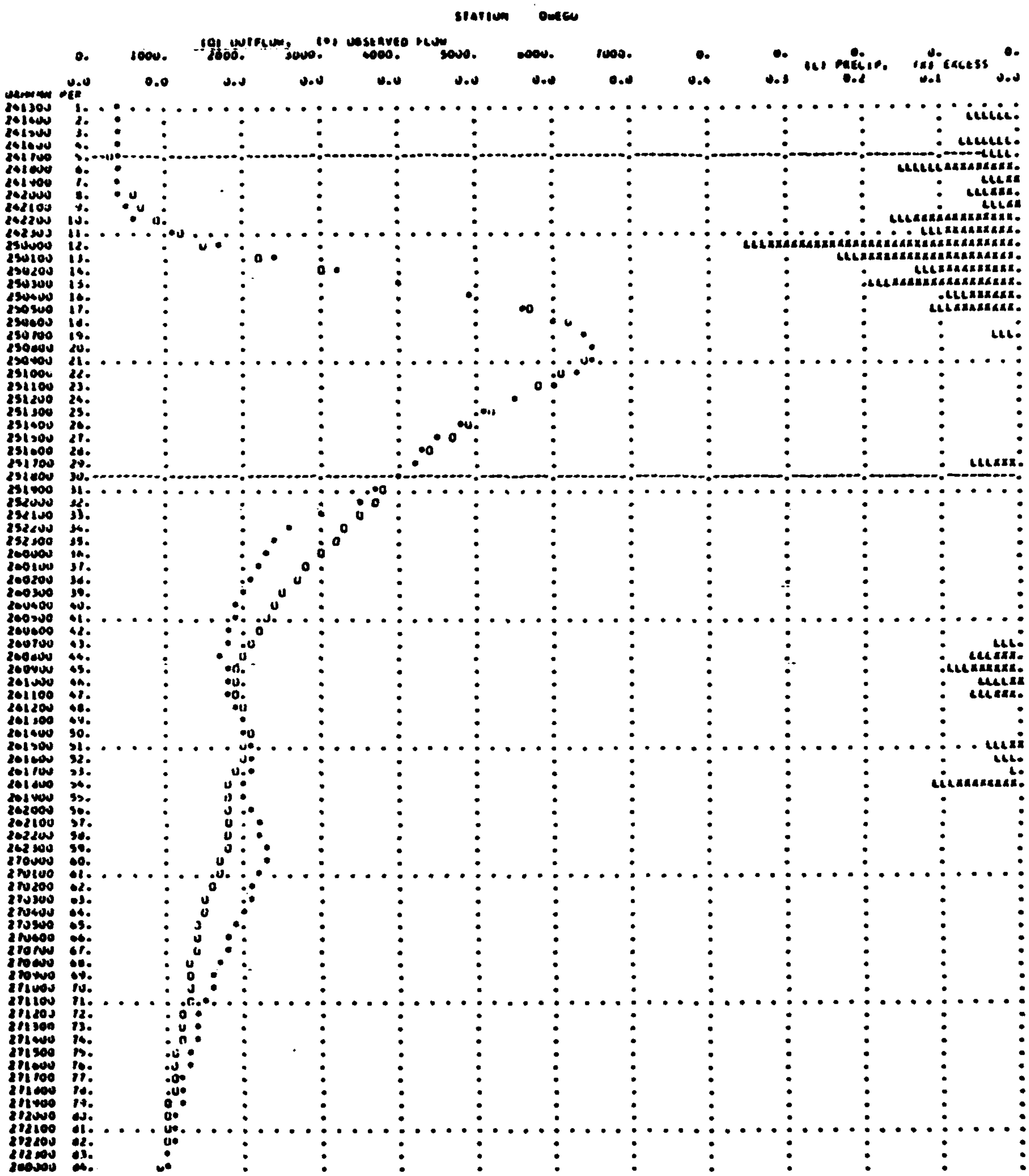
HYDROGRAPH AT STATION OWEGO

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 SEP 1300 | 1 | 0.00 | 0.00 | 0.00 | 380. | 380. | 26 SEP 0700 | 43 | 0.03 | 0.03 | 0.00 | 2054. | 1760. |
| 24 SEP 1400 | 2 | 0.06 | 0.06 | 0.00 | 372. | 376. | 26 SEP 0800 | 44 | 0.06 | 0.03 | 0.03 | 1954. | 1744. |
| 24 SEP 1500 | 3 | 0.00 | 0.00 | 0.00 | 364. | 376. | 26 SEP 0900 | 45 | 0.09 | 0.03 | 0.06 | 1892. | 1752. |
| 24 SEP 1600 | 4 | 0.07 | 0.07 | 0.00 | 356. | 380. | 26 SEP 1000 | 46 | 0.05 | 0.03 | 0.01 | 1883. | 1794. |
| 24 SEP 1700 | 5 | 0.04 | 0.04 | 0.00 | 348. | 380. | 26 SEP 1100 | 47 | 0.06 | 0.03 | 0.03 | 1921. | 1836. |
| 24 SEP 1800 | 6 | 0.15 | 0.06 | 0.09 | 368. | 389. | 26 SEP 1200 | 48 | 0.00 | 0.00 | 0.00 | 1966. | 1905. |
| 24 SEP 1900 | 7 | 0.04 | 0.03 | 0.01 | 439. | 389. | 26 SEP 1300 | 49 | 0.00 | 0.00 | 0.00 | 2042. | 1964. |
| 24 SEP 2000 | 8 | 0.06 | 0.03 | 0.03 | 557. | 412. | 26 SEP 1400 | 50 | 0.00 | 0.00 | 0.00 | 2060. | 2032. |
| 24 SEP 2100 | 9 | 0.04 | 0.03 | 0.01 | 709. | 470. | 26 SEP 1500 | 51 | 0.04 | 0.03 | 0.01 | 2025. | 2075. |
| 24 SEP 2200 | 10 | 0.16 | 0.03 | 0.13 | 901. | 621. | 26 SEP 1600 | 52 | 0.03 | 0.03 | 0.00 | 1954. | 2083. |
| 24 SEP 2300 | 11 | 0.12 | 0.03 | 0.09 | 1157. | 1097. | 26 SEP 1700 | 53 | 0.01 | 0.01 | 0.00 | 1867. | 2075. |
| 25 SEP 0000 | 12 | 0.35 | 0.03 | 0.32 | 1544. | 1712. | 26 SEP 1800 | 54 | 0.11 | 0.03 | 0.08 | 1802. | 2049. |
| 25 SEP 0100 | 13 | 0.23 | 0.03 | 0.20 | 2163. | 2374. | 26 SEP 1900 | 55 | 0.00 | 0.00 | 0.00 | 1783. | 2049. |
| 25 SEP 0200 | 14 | 0.13 | 0.03 | 0.10 | 2997. | 3176. | 26 SEP 2000 | 56 | 0.00 | 0.00 | 0.00 | 1798. | 2092. |
| 25 SEP 0300 | 15 | 0.19 | 0.03 | 0.16 | 3952. | 4014. | 26 SEP 2100 | 57 | 0.00 | 0.00 | 0.00 | 1823. | 2176. |
| 25 SEP 0400 | 16 | 0.09 | 0.03 | 0.06 | 4885. | 4864. | 26 SEP 2200 | 58 | 0.00 | 0.00 | 0.00 | 1835. | 2248. |
| 25 SEP 0500 | 17 | 0.11 | 0.03 | 0.08 | 5660. | 5570. | 26 SEP 2300 | 59 | 0.00 | 0.00 | 0.00 | 1814. | 2204. |
| 25 SEP 0600 | 18 | 0.00 | 0.00 | 0.00 | 6184. | 6000. | 27 SEP 0000 | 60 | 0.00 | 0.00 | 0.00 | 1749. | 2284. |
| 25 SEP 0700 | 19 | 0.03 | 0.03 | 0.00 | 6433. | 6382. | 27 SEP 0100 | 61 | 0.00 | 0.00 | 0.00 | 1658. | 2230. |
| 25 SEP 0800 | 20 | 0.00 | 0.00 | 0.00 | 6478. | 6494. | 27 SEP 0200 | 62 | 0.00 | 0.00 | 0.00 | 1570. | 2143. |
| 25 SEP 0900 | 21 | 0.00 | 0.00 | 0.00 | 6357. | 6456. | 27 SEP 0300 | 63 | 0.00 | 0.00 | 0.00 | 1495. | 2058. |
| 25 SEP 1000 | 22 | 0.00 | 0.00 | 0.00 | 6120. | 6326. | 27 SEP 0400 | 64 | 0.00 | 0.00 | 0.00 | 1462. | 1981. |
| 25 SEP 1100 | 23 | 0.00 | 0.00 | 0.00 | 5824. | 6004. | 27 SEP 0500 | 65 | 0.00 | 0.00 | 0.00 | 1430. | 1913. |
| 25 SEP 1200 | 24 | 0.00 | 0.00 | 0.00 | 5515. | 5548. | 27 SEP 0600 | 66 | 0.03 | 0.03 | 0.00 | 1399. | 1828. |
| 25 SEP 1300 | 25 | 0.00 | 0.00 | 0.00 | 5220. | 5104. | 27 SEP 0700 | 67 | 0.00 | 0.00 | 0.00 | 1368. | 1752. |
| 25 SEP 1400 | 26 | 0.00 | 0.00 | 0.00 | 4942. | 4768. | 27 SEP 0800 | 68 | 0.00 | 0.00 | 0.00 | 1338. | 1672. |
| 25 SEP 1500 | 27 | 0.00 | 0.00 | 0.00 | 4679. | 4492. | 27 SEP 0900 | 69 | 0.00 | 0.00 | 0.00 | 1309. | 1608. |
| 25 SEP 1600 | 28 | 0.00 | 0.00 | 0.00 | 4430. | 4311. | 27 SEP 1000 | 70 | 0.00 | 0.00 | 0.00 | 1280. | 1552. |
| 25 SEP 1700 | 29 | 0.06 | 0.03 | 0.03 | 4202. | 4190. | 27 SEP 1100 | 71 | 0.00 | 0.00 | 0.00 | 1252. | 1488. |
| 25 SEP 1800 | 30 | 0.00 | 0.00 | 0.00 | 4000. | 3981. | 27 SEP 1200 | 72 | 0.00 | 0.00 | 0.00 | 1225. | 1440. |
| 25 SEP 1900 | 31 | 0.00 | 0.00 | 0.00 | 3820. | 3739. | 27 SEP 1300 | 73 | 0.00 | 0.00 | 0.00 | 1198. | 1390. |
| 25 SEP 2000 | 32 | 0.00 | 0.00 | 0.00 | 3654. | 3453. | 27 SEP 1400 | 74 | 0.00 | 0.00 | 0.00 | 1172. | 1360. |
| 25 SEP 2100 | 33 | 0.00 | 0.00 | 0.00 | 3493. | 3035. | 27 SEP 1500 | 75 | 0.00 | 0.00 | 0.00 | 1146. | 1315. |
| 25 SEP 2200 | 34 | 0.00 | 0.00 | 0.00 | 3331. | 2640. | 27 SEP 1600 | 76 | 0.00 | 0.00 | 0.00 | 1121. | 1277. |
| 25 SEP 2300 | 35 | 0.00 | 0.00 | 0.00 | 3165. | 2410. | 27 SEP 1700 | 77 | 0.00 | 0.00 | 0.00 | 1096. | 1240. |
| 26 SEP 0000 | 36 | 0.00 | 0.00 | 0.00 | 2998. | 2266. | 27 SEP 1800 | 78 | 0.00 | 0.00 | 0.00 | 1072. | 1202. |
| 26 SEP 0100 | 37 | 0.00 | 0.00 | 0.00 | 2839. | 2160. | 27 SEP 1900 | 79 | 0.00 | 0.00 | 0.00 | 1049. | 1173. |
| 26 SEP 0200 | 38 | 0.00 | 0.00 | 0.00 | 2690. | 2066. | 27 SEP 2000 | 80 | 0.00 | 0.00 | 0.00 | 1026. | 1135. |
| 26 SEP 0300 | 39 | 0.00 | 0.00 | 0.00 | 2548. | 1981. | 27 SEP 2100 | 81 | 0.00 | 0.00 | 0.00 | 1003. | 1098. |
| 26 SEP 0400 | 40 | 0.00 | 0.00 | 0.00 | 2414. | 1913. | 27 SEP 2200 | 82 | 0.00 | 0.00 | 0.00 | 981. | 1067. |
| 26 SEP 0500 | 41 | 0.00 | 0.00 | 0.00 | 2287. | 1854. | 27 SEP 2300 | 83 | 0.00 | 0.00 | 0.00 | 960. | 1039. |
| 26 SEP 0600 | 42 | 0.00 | 0.00 | 0.00 | 2167. | 1794. | 28 SEP 0000 | 84 | 0.00 | 0.00 | 0.00 | 939. | 1011. |

TOTAL RAINFALL = 2.44, TOTAL LOSS = 0.91, TOTAL EXCESS = 1.53

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 83.00-HR |
|---|---|---|---|---|---|---|
| 6478. | 19.00 | (CFS) | 6219. | 4626. | 2639. | 2362. |
| | | (INCHES) | 0.313 | 0.930 | 1.591 | 1.642 |
| | | (AC-FT) | 3084. | 9175. | 15702. | 16204. |

CUMULATIVE AREA = 105.00 SQ MI




(-) LIMITS OF OPTIMIZATION

```
                                          HEC-1 INPUT                                                    PAGE  1

LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        OWEGO CREEK     10-17-77
  2           ID        UNIT GRAPH (CLARK) AND LOSS RATE OPTIMIZATION (UNIFORM)
  3           IT      60 16OCT77    0400      75
  4           IO       1       2
  5           OU      10      50
  6           PG     CAN    2.92
  7           PG  LISLE     3.63
  8           PG  NEWVAL
  9           PI     .00     .00     .00     .00     .00     .00     .00     .00     .20     .00
 10           PI     .10     .00     .10     .10     .00     .20     .10     .00     .10     .20
 11           PI     .00     .20     .00     .20     .10     .20     .10     .10     .10     .10
 12           PI     .00     .10     .00     .00     .00     .00     .00     .00     .00     .00
 13           PG    WHPT
 14           PI     .00     .00     .00     .00     .00     .00     .10     .10     .00     .10
 15           PI     .00     .00     .10     .00     .10     .10     .00     .10     .10     .10
 16           PI     .10     .10     .00     .20     .00     .10     .10     .00     .10     .00
 17           PI     .20     .00     .00     .00     .00     .00     .00     .00     .00     .00
 18           PG   HUCOR
 19           PI     .00     .10     .00     .00     .00     .00     .00     .10     .10     .10
 20           PI     .00     .00     .10     .00     .10     .10     .10     .00     .00     .10
 21           PI     .20     .00     .00     .20     .10     .10     .10     .10     .00     .10
 22           PI     .00     .10     .00     .00     .00     .00     .00     .00     .00     .00
 23           PG    MTPL
 24           PI     .01     .06     .07     .00     .04     .04     .05     .11     .09     .05
 25           PI     .06     .06     .14     .08     .05     .12     .15     .05     .07     .08
 26           PI     .15     .10     .08     .13     .20     .12     .04     .00     .00     .00
 27           PI     .00     .00     .00     .00     .00     .00     .05     .02     .00     .00

 28           KK   OWEGO
 29           QO     340     332     328     324     324     320     316     316     316     320
 30           QO     324     336     372     443     565     718     927    1120    1338    1592
 31           QO    1888    2365    2936    3464    3805    4025    4267    4624    4936    5140
 32           QO    5320    5416    5556    5654    5640    5542    5440    5332    5224    5104
 33           QO    5008    4876    4732    4528    4289    3992    3717    3453    3222    3035
 34           QO    2881    2738    2620    2512    2419    2320    2230    2151    2066    2006
 35           QO    1921    1888    1845    1794    1760    1728    1704    1680    1656    1640
 36           QO    1624    1600    1576    1544    1520       0       0       0       0       0
 37           PT     CAN   LISLE  NEWVAL   HUCOR    MTPL
 38           PW     .18     .01     .40     .30     .11
 39           PR  NEWVAL    WHPT   HUCOR    MTPL
 40           PW     .56     .01     .30     .13
 41           BA    185.      0.
 42           BF    340.   1800.  1.0224
 43           UC    -7.0    -18.
 44           LU     -.2    -.05
 45           ZZ
```

COMPARISON OF COMPUTED AND OBSERVED HYDROGRAPHS

STATISTICS BASED ON OPTIMIZATION REGION
(ORDINATES 10 THROUGH 50)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.523 | | 21.82 | | | |
| COMPUTED HYDROGRAPH | 140954. | 1.181 | 3438. | 34.45 | 12.64 | 5910. | 34.00 |
| OBSERVED HYDROGRAPH | 140585. | 1.178 | 3429. | 34.72 | 12.91 | 5654. | 33.00 |
| DIFFERENCE | 369. | 0.003 | 9. | -0.27 | -0.27 | 256. | 1.00 |
| PERCENT DIFFERENCE | 0.26 | | | | -2.09 | 4.52 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 257. | AVERAGE ABSOLUTE ERROR | 225. |
| OBJECTIVE FUNCTION | 258. | AVERAGE PERCENT ABSOLUTE ERROR | 12.09 |

STATISTICS BASED ON FULL HYDROGRAPH
(ORDINATES 1 THROUGH 75)

| | SUM OF FLOWS | EQUIV DEPTH | MEAN FLOW | TIME TO CENTER OF MASS | LAG C.M. TO C.M. | PEAK FLOW | TIME OF PEAK |
|---|---|---|---|---|---|---|---|
| PRECIPITATION EXCESS | | 1.523 | | 21.82 | | | |
| COMPUTED HYDROGRAPH | 188426. | 1.578 | 2512. | 40.38 | 18.56 | 5910. | 34.00 |
| OBSERVED HYDROGRAPH | 192924. | 1.616 | 2572. | 41.16 | 19.35 | 5654. | 33.00 |
| DIFFERENCE | -4498. | -0.038 | -60. | -0.79 | -0.79 | 256. | 1.00 |
| PERCENT DIFFERENCE | -2.33 | | | | -4.07 | 4.52 | |

| | | | |
|---|---|---|---|
| STANDARD ERROR | 222. | AVERAGE ABSOLUTE ERROR | 186. |
| OBJECTIVE FUNCTION | 245. | AVERAGE PERCENT ABSOLUTE ERROR | 11.45 |

UNIT HYDROGRAPH
97 END-OF-PERIOD ORDINATES

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 148. | 557. | 1144. | 1843. | 2622. | 3419. | 4123. | 4669. | 5044. | 5209. |
| 5090. | 4810. | 4539. | 4284. | 4043. | 3815. | 3601. | 3398. | 3207. | 3027. |
| 2857. | 2696. | 2544. | 2401. | 2266. | 2139. | 2018. | 1905. | 1798. | 1697. |
| 1601. | 1511. | 1426. | 1346. | 1270. | 1199. | 1131. | 1068. | 1008. | 951. |
| 898. | 847. | 799. | 755. | 712. | 672. | 634. | 599. | 565. | 533. |
| 503. | 475. | 448. | 423. | 399. | 377. | 356. | 336. | 317. | 299. |
| 282. | 266. | 251. | 237. | 224. | 211. | 199. | 188. | 178. | 168. |
| 158. | 149. | 141. | 133. | 125. | 118. | 112. | 105. | 100. | 94. |
| 89. | 84. | 79. | 74. | 70. | 66. | 63. | 59. | 56. | 53. |
| 50. | 47. | 44. | 42. | 39. | 37. | 35. | | | |

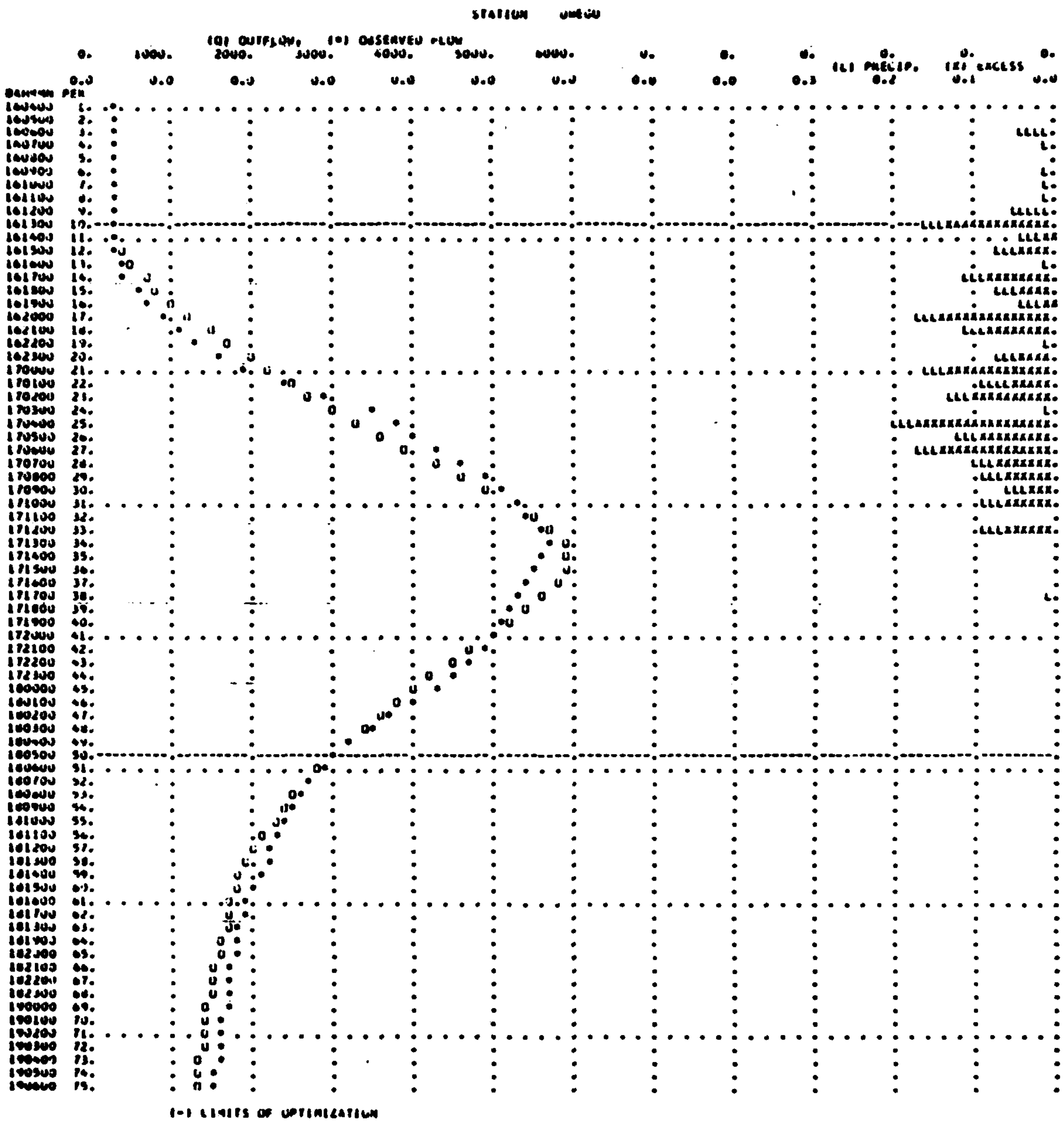
HYDROGRAPH AT STATION OMEGO

| DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q | DA MON HRMN | ORD | RAIN | LOSS | EXCESS | COMP Q | OBS Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 OCT 0400 | 1 | 0.00 | 0.00 | 0.00 | 340. | 340. | 17 OCT 1800 | 39 | 0.00 | 0.00 | 0.00 | 5426. | 5224. |
| 16 OCT 0500 | 2 | 0.00 | 0.00 | 0.00 | 333. | 332. | 17 OCT 1900 | 40 | 0.00 | 0.00 | 0.00 | 5205. | 5104. |
| 16 OCT 0600 | 3 | 0.04 | 0.04 | 0.00 | 325. | 328. | 17 OCT 2000 | 41 | 0.00 | 0.00 | 0.00 | 4966. | 5008. |
| 16 OCT 0700 | 4 | 0.01 | 0.01 | 0.00 | 318. | 324. | 17 OCT 2100 | 42 | 0.00 | 0.00 | 0.00 | 4719. | 4876. |
| 16 OCT 0800 | 5 | 0.00 | 0.00 | 0.00 | 311. | 324. | 17 OCT 2200 | 43 | 0.00 | 0.00 | 0.00 | 4469. | 4732. |
| 16 OCT 0900 | 6 | 0.01 | 0.01 | 0.00 | 304. | 320. | 17 OCT 2300 | 44 | 0.00 | 0.00 | 0.00 | 4223. | 4528. |
| 16 OCT 1000 | 7 | 0.01 | 0.01 | 0.00 | 298. | 316. | 18 OCT 0000 | 45 | 0.00 | 0.00 | 0.00 | 3990. | 4289. |
| 16 OCT 1100 | 8 | 0.01 | 0.01 | 0.00 | 291. | 316. | 18 OCT 0100 | 46 | 0.00 | 0.00 | 0.00 | 3770. | 3992. |
| 16 OCT 1200 | 9 | 0.05 | 0.05 | 0.00 | 285. | 316. | 18 OCT 0200 | 47 | 0.00 | 0.00 | 0.00 | 3562. | 3717. |
| 16 OCT 1300 | 10 | 0.16 | 0.03 | 0.13 | 297. | 320. | 18 OCT 0300 | 48 | 0.00 | 0.00 | 0.00 | 3366. | 3453. |
| 16 OCT 1400 | 11 | 0.04 | 0.03 | 0.01 | 345. | 324. | 18 OCT 0400 | 49 | 0.00 | 0.00 | 0.00 | 3181. | 3222. |
| 16 OCT 1500 | 12 | 0.07 | 0.03 | 0.04 | 424. | 336. | 18 OCT 0500 | 50 | 0.00 | 0.00 | 0.00 | 3006. | 3035. |
| 16 OCT 1600 | 13 | 0.01 | 0.01 | 0.00 | 528. | 372. | 18 OCT 0600 | 51 | 0.00 | 0.00 | 0.00 | 2841. | 2881. |
| 16 OCT 1700 | 14 | 0.11 | 0.03 | 0.08 | 662. | 443. | 18 OCT 0700 | 52 | 0.00 | 0.00 | 0.00 | 2685. | 2738. |
| 16 OCT 1800 | 15 | 0.07 | 0.03 | 0.04 | 830. | 565. | 18 OCT 0800 | 53 | 0.00 | 0.00 | 0.00 | 2538. | 2620. |
| 16 OCT 1900 | 16 | 0.04 | 0.03 | 0.01 | 1016. | 718. | 18 OCT 0900 | 54 | 0.00 | 0.00 | 0.00 | 2399. | 2512. |
| 16 OCT 2000 | 17 | 0.17 | 0.03 | 0.14 | 1220. | 927. | 18 OCT 1000 | 55 | 0.00 | 0.00 | 0.00 | 2267. | 2419. |
| 16 OCT 2100 | 18 | 0.11 | 0.03 | 0.08 | 1457. | 1120. | 18 OCT 1100 | 56 | 0.00 | 0.00 | 0.00 | 2143. | 2320. |
| 16 OCT 2200 | 19 | 0.01 | 0.01 | 0.00 | 1712. | 1338. | 18 OCT 1200 | 57 | 0.00 | 0.00 | 0.00 | 2026. | 2230. |
| 16 OCT 2300 | 20 | 0.07 | 0.03 | 0.04 | 1951. | 1592. | 18 OCT 1300 | 58 | 0.00 | 0.00 | 0.00 | 1916. | 2151. |
| 17 OCT 0000 | 21 | 0.16 | 0.03 | 0.13 | 2193. | 1888. | 18 OCT 1400 | 59 | 0.00 | 0.00 | 0.00 | 1811. | 2066. |
| 17 OCT 0100 | 22 | 0.09 | 0.03 | 0.05 | 2462. | 2365. | 18 OCT 1500 | 60 | 0.00 | 0.00 | 0.00 | 1765. | 2006. |
| 17 OCT 0200 | 23 | 0.13 | 0.03 | 0.10 | 2748. | 2936. | 18 OCT 1600 | 61 | 0.00 | 0.00 | 0.00 | 1726. | 1921. |
| 17 OCT 0300 | 24 | 0.01 | 0.01 | 0.00 | 3030. | 3464. | 18 OCT 1700 | 62 | 0.00 | 0.00 | 0.00 | 1689. | 1888. |
| 17 OCT 0400 | 25 | 0.20 | 0.03 | 0.17 | 3312. | 3805. | 18 OCT 1800 | 63 | 0.00 | 0.00 | 0.00 | 1652. | 1845. |
| 17 OCT 0500 | 26 | 0.12 | 0.03 | 0.09 | 3618. | 4025. | 18 OCT 1900 | 64 | 0.00 | 0.00 | 0.00 | 1615. | 1794. |
| 17 OCT 0600 | 27 | 0.17 | 0.03 | 0.14 | 3935. | 4267. | 18 OCT 2000 | 65 | 0.00 | 0.00 | 0.00 | 1580. | 1760. |
| 17 OCT 0700 | 28 | 0.10 | 0.03 | 0.07 | 4261. | 4624. | 18 OCT 2100 | 66 | 0.00 | 0.00 | 0.00 | 1545. | 1728. |
| 17 OCT 0800 | 29 | 0.09 | 0.03 | 0.06 | 4605. | 4936. | 18 OCT 2200 | 67 | 0.00 | 0.00 | 0.00 | 1512. | 1704. |
| 17 OCT 0900 | 30 | 0.06 | 0.03 | 0.03 | 4948. | 5140. | 18 OCT 2300 | 68 | 0.00 | 0.00 | 0.00 | 1478. | 1680. |
| 17 OCT 1000 | 31 | 0.09 | 0.03 | 0.06 | 5256. | 5320. | 19 OCT 0000 | 69 | 0.00 | 0.00 | 0.00 | 1446. | 1656. |
| 17 OCT 1100 | 32 | 0.00 | 0.00 | 0.00 | 5513. | 5416. | 19 OCT 0100 | 70 | 0.00 | 0.00 | 0.00 | 1414. | 1640. |
| 17 OCT 1200 | 33 | 0.09 | 0.03 | 0.06 | 5713. | 5556. | 19 OCT 0200 | 71 | 0.00 | 0.00 | 0.00 | 1383. | 1624. |
| 17 OCT 1300 | 34 | 0.00 | 0.00 | 0.00 | 5852. | 5654. | 19 OCT 0300 | 72 | 0.00 | 0.00 | 0.00 | 1353. | 1600. |
| 17 OCT 1400 | 35 | 0.00 | 0.00 | 0.00 | 5910. | 5640. | 19 OCT 0400 | 73 | 0.00 | 0.00 | 0.00 | 1323. | 1576. |
| 17 OCT 1500 | 36 | 0.00 | 0.00 | 0.00 | 5880. | 5542. | 19 OCT 0500 | 74 | 0.00 | 0.00 | 0.00 | 1294. | 1544. |
| 17 OCT 1600 | 37 | 0.00 | 0.00 | 0.00 | 5777. | 5440. | 19 OCT 0600 | 75 | 0.00 | 0.00 | 0.00 | 1266. | 1520. |
| 17 OCT 1700 | 38 | 0.01 | 0.01 | 0.00 | 5620. | 5332. | | | | | | | |

TOTAL RAINFALL = 2.30, TOTAL LOSS = 0.78, TOTAL EXCESS = 1.52

| PEAK FLOW (CFS) | TIME (HR) | | MAXIMUM AVERAGE FLOW 6-HR | 24-HR | 72-HR | 74.00-HR |
|---|---|---|---|---|---|---|
| 5910. | 34.00 | (CFS) | 5783. | 4743. | 2597. | 2535. |
| | | (INCHES) | 0.291 | 0.953 | 1.566 | 1.572 |
| | | (AC-FT) | 2868. | 9407. | 15451. | 15506. |

CUMULATIVE AREA = 185.00 SQ MI


STATION
(O) OUTFLOW, (*) OBSERVED FLOW
0. 1000. 2000. 3000. 4000. 5000. 6000.
(L) PRECIP, (X) EXCESS
(-) LIMITS OF OPTIMIZATION

## Appendix D -- Statistical Results of Verification Storms

| Basin/Storm | % Lag C.M. to C.M. | % Peak Flow | Time to Peak | Avg % Abs Error | OBJ Func |
|---|---|---|---|---|---|
| Butternut Ck. | | | | | |
| 10-18-75 | 1.37 | -14.92 | 0. | 15.39 | 248 |
| Canasawacta Ck. | | | | | |
| 7-31-71 | 5.73 | 130.85 | 3. | 238.17 | 1514 |
| Corey Ck. | | | | | |
| 10-09-76 | 3.35 | 9.79 | -2. | 37.96 | 62 |
| Elk Run Ck. | | | | | |
| 8-06-78 | 44.73 | 109.13 | 0. | 118.80 | 197 |
| Five Mile Ck. | | | | | |
| 9-25-77 | -10.92 | -40.37 | 2. | 31.17 | 529 |
| Newtown Ck. | | | | | |
| 10-09-76 | 1.17 | 28.91 | -1. | 32.62 | 450 |
| 10-28-81 | 38.41 | 9.49 | 0. | 37.62 | 331 |
| Ostelic River | | | | | |
| 10-09-76 | 9.85 | -20.67 | 5. | 27.60 | 1223 |
| Owego Ck. | | | | | |
| 10-09-76 | 3.15 | 36.59 | 0. | 47.24 | 1903 |

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